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Reforestation
Pennsylvania's Idle Land
As a
Self-Liquidating Public Work



(Bulletin 51)

Compiled by the
Pennsylvania Forest Research Institute
E. A. Ziegler, Director

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS
Harrisburg
1933

FOREWORD

The data and information contained in this bulletin present conditions as they exist in Pennsylvania today.

It is not the intention to outline a future forest policy, but rather to call attention to the immediate need for the utilization of millions of acres of idle land in our Commonwealth so that they may yield their just share of taxes, provide a crop revenue, and furnish work for many of those who are unemployed.

We have land enough in Pennsylvania adapted to forestry purposes to grow all the timber we need. It is essential to the best interests of our State and the welfare of our people that production be brought back on a sound basis. Economics, important as they are, will fail unless this is done.

LEWIS E. STALEY

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS



Lewis E. Staley, *Secretary*
John W. Keller, *Deputy Secretary*

REFORESTING PENNSYLVANIA'S IDLE LAND AS A SELF-LIQUIDATING PUBLIC WORK

Compiled by the
PENNSYLVANIA FOREST RESEARCH INSTITUTE
E. A. Ziegler, *Director*

Pennsylvania has upward of 4,000,000 acres of idle land in need of being put to work. This is one-seventh of the State area. This land has been cast off by the farmers to the extent of 1.5 million acres of cleared farm land from 1880 to 1910, and 2.3 million more since 1910 (Table 1). From 1925 to 1930 open farm land was being dropped from agricultural use at the rate of 108,000 acres per year. Although some of these earlier lands are naturally reforesting to low grade hardwoods, there are still hundreds of thousands of acres of cutover forest so badly burned that they must be reforested to earn their carrying costs and protect our waters and water powers, whether kept in private ownership or taken over into government ownership. It is surprising how well our farmers by sheer pluck and frugality are keeping ahead of the sheriff tax sales on the *better lands*. It is not surprising to see these *non-productive lands* increasing the tax sales to a degree that is alarming some of our county fiscal officers.

Tax Sales of Lands Rising

For instance, Centre County¹ has sold an average of 22,000 acres of "unseated" land at each biennial tax sale for the 28 years from 1900 to 1928, not including sales of land which the owner redeemed within the statutory two years. In 1930 the tax sales of this class of land rose to 42,663 acres (unredeemed). The county on July 1, 1932, held tax title to over 28,000 acres, which no private purchaser would bid in even for the taxes. And in 1932 a further 59,000 acres of "unseated" land was advertised for tax sale, making a total of 87,000 acres in the hands of the county or advertised for tax sale. This is 22 per cent of the 399,000 acres of private "unseated" land in the county.

Still more actively farmed poor land is moving toward the tax block in Centre County in increasing amounts. From 1900 to 1912 an average of 291 acres of "seated" land was sold and not redeemed in each biennial sale. From 1914 to 1928, 424 acres were sold (excluding redeemed land) each biennium; in 1930, 1,438 acres were sold and not redeemed; and in 1932, 3,299 acres of "seated" land were advertised (tax sale not yet held).

While Centre County is perhaps above the average for tax sales in the State, it marks a process going on in all the counties.

¹"Forest Taxation in Centre County, Pennsylvania, Progress Report No. 5, 1932," by E. A. Ziegler, Director, Pa. Forest Research Institute, and Secretary, Pennsylvania Mineral and Forest Land Taxation Commission.

TABLE I
Rise and Fall in Pennsylvania Farm Land Areas

Census Year	Total Land in Farms	Improved Land in Farms	
		Total	Average Yearly Increase or Decrease
(Thousands of acres)			
1850	14,923	8,629	...
1860	17,012	10,463	183
1870	17,994	11,516	115
1880	19,791	13,423	191
1890	18,364	13,210	— 21
1900	19,371	13,209	0
1910	18,587	12,674	— 54
1920	17,658	11,848	— 83
1925	18,296	10,129	— 344*
1930	15,309	9,593	— 108

* In the 1925 and 1930 Census enumerations the old division of "improved" and "unimproved" farm lands was dropped for a more intensive classification. At the top of p. 581, "Statistical Abstract of the U. S., 1925" U. S. Dept. of Commerce, a note states that the combined "crop land" and "plowable pasture land" of the 1925 Census corresponds in a rough way with "improved land" of the earlier census periods. It should be observed, however, that previous to 1925 house and barn lots are included in "improved" land, but in 1925 and 1930 they are excluded, so that the loss in improved land as shown is somewhat too high for 1920-25 when the change was made, and not high enough for 1925-30, by the area of barn and house lots not included.

Will This Land Be Needed Again For Agriculture?

Table I shows that total land in farms and improved land in farms have been decreasing in Pennsylvania since 1880. Even the war prices of farm products were not sufficient to stop this abandonment of inferior agricultural land. The Federal Department of Agriculture² points out that our agricultural crops are showing overproduction because of the following causes:

- (1) Other nations (Canada, Argentine, Australia) have largely increased their wheat area, as has the western United States.
- (2) The substitution of autos, trucks and tractors for horses and mules on and off the farm has blotted out the market for 25 million acres of animal feeds and increased products for other markets by that much.
- (3) Increased yields per acre, more efficient breeds of farm animals and feeding are reducing the need for additional farm land.
- (4) Imports of vegetable oils, sugar and other foods, and some change in our own food habits, are reducing the need for more cereal lands.

² U. S. Dept. Agr. "Miscellaneous Pub. No. 97," 1930 by Gray and Baker.

(5) And, finally, the rapid falling off in our population increase is the largest brake on agricultural expansion.

A critical study of the use of abandoned low grade agricultural lands and cut-over forest lands has convinced our economists that agriculture can not absorb most of them for generations, if ever.

In Pennsylvania an interesting parallel is noted (Fig. 1) in that our use of agricultural land began to fall off at the exact time our lumber and forest industry started its precipitous decline. This is not a coincidence. The loss of the forest industry as a market for nearby agricultural lands, and as a part time employment for the farmers in the near-by mountain valleys, was a large cause of farm abandonment in these sections of our State.

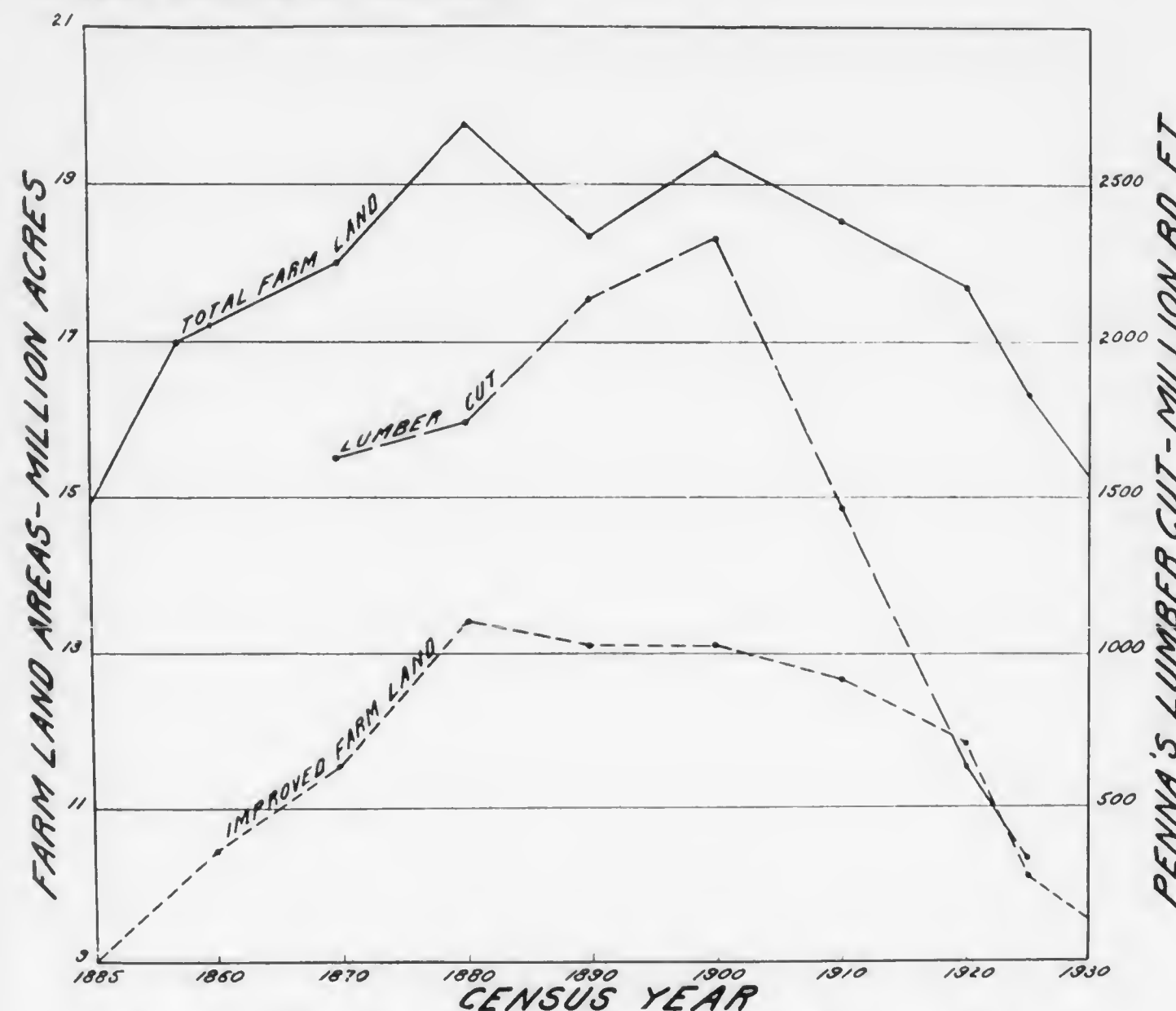


Figure 1. The rise and fall of Pennsylvania's farm land areas and lumber cut.

Small mountain farms are maintained generation after generation by forest workers in Germany's Black Forest region. This forest, the Schifferschaft Wald, is a stock company with the state of Baden owning some of the stock. It employs 175 men constantly on 12,500 acres of forest (with small farms and gardens) and pays dividends. In 1914 this forest was valued at \$300 per acre. One-third of this forest had been cut clean in early days and grazed. The grazing became a vested right and was bought out for \$20,000 and the land reforested by the company since its timber crop was worth much more than the grazing.

The Best and Only Use For Abandoned Lands

There are but three productive uses for large areas of land—agriculture, forests, and grazing. Of these forest growing is least exacting in soil fertility and will succeed after the other two have failed, as is the case with the several million acres of abandoned farm lands of our State. But the protection of our streams and rich bottom lands, the employment of our workers, and the need for tax contribution from this large land area, all demand that these lands be put to productive use. *The single solution is reforestation.*

Water flow conservation and power use are joined with effective forest cover in the Black Forest of Germany on the Schonmunzach River.

These forest lands (the Schifferschaft Wald on the watershed of this river) now worth over \$300 per acre, were once a mixture of cut-over forest and cleared grass lands which have been restored partly by planting, by complete fire protection, and by forest management. Our idle lands in Pennsylvania can be made equally productive.

Forests Represent One Crop Where Consumption Exceeds Growth

A recent special national report to the U. S. Timber Conservation Board, appointed by President Hoover, points out that the latest revised estimates indicate an average annual demand on the forests of the United States of 16 billion cubic feet of wood, but there is now grown only 7 billion cubic feet annually in saw timber and cordwood sizes. Even including growth in young stands below cordwood size, the total growth is placed at less than 11 billion cubic feet. We must agree, therefore, with the final conclusion which states: "Obviously, then there is no reason to fear overproduction of timber. There is reason to fear underproduction unless the best methods that can be devised are employed in handling the better lands at least, and unless the remainder of our forests are kept reasonably productive."

While this national survey shows that growing timber is a productive enterprise in no danger of excessive development nationally, even when the enormous timber region of the South (now largely cut out) and the North West are included, a study of Pennsylvania's normal wood consumption and growth will show an even greater deficiency on the growth side of the ledger.

Pennsylvania's Wood Consumption and Growth

Normally Pennsylvania consumes about 1,900,000³ board feet of lumber each year. She cuts within her borders less than one sixth this quantity and imports the rest, principally from the South and Pacific Coast. In addition, almost our entire pole supply, and a large part of our rail-road ties, mine timbers, and pulp wood come from beyond our State borders. In normal years as much as \$100,000,000 worth of wood is bought outside the State by our people.

We have but a fraction of the standing growing timber we should have for self support in Pennsylvania. Our forests should average 3,000 to 5,000 cubic feet of growing trees per acre. We have not over a sixth of this. Our forests once contained magnificent areas of pine

³ U. S. Dept. Agr. Statistical Bul. No. 21.

and hemlock, so that three-fourths of our lumber cut was soft wood,—the structural timber most in demand. Now our second growth forests are 90 per cent hardwood including much cull material. Our structural lumber markets, our paper mills and our pole users call for hemlock, spruce and pine—and we do not have it.

Soft woods are not coming back naturally in our forests, which are changed by ax and fire to hardwoods.

Forest planting experience by the Pennsylvania Department of Forests and Waters over 25 years have demonstrated that it is cheaper to buy old abandoned fields and plant them to coniferous forest than to convert scrub hardwood to conifers by planting and repeated cutting back of competing hardwood sprouts. Pennsylvania needs more coniferous forest much more than the inferior hardwoods she is getting all too often by mere fire protection.

The freight saving of \$10 to \$15 per thousand board feet of lumber from the Pacific Coast will alone pay the cost of growing much of our own timber on our abandoned lands at home. Idaho white pine match stock costs \$19.58 freight per thousand board feet to a Pennsylvania match factory. This stock was once produced at home, and can be again.

Private Land Owners Slow to Plant Timber

Although much of our abandoned farm land is so scattered that reforestation is most feasible by private owners of surrounding property, yet the average private land owner is slow to proceed. The expense of planting, the carrying taxes, and the long wait to the cutting time and time of money income, and especially his lack of knowledge of costs, methods, and timber values, makes him indifferent. Leadership is necessary. The State should supply that leadership.

A Canvass of Idle Lands

A State reforestation policy would immediately be concerned with such practical problems as these:

(1) How much of this open idle land could be secured in contiguous blocks large enough for keeping forest management and protection costs within reasonable limits? New York State⁴ has adopted a block of 500 acres as a minimum for state reforestation administration. It encourages counties to acquire smaller reforestation areas as "county forests" with a State-aid system, limited to a fifty per cent State contribution of not over \$5,000 to any county per year.

(2) At what average prices could such land be purchased? From the passage of the New York Reforestation Act in 1929 to January 1, 1932, New York purchased 79,856 acres of abandoned farm land at an average price of \$3.79 per acre, on which 27 million forest trees have already been set out. With some natural growth, 33,400 acres of the 79,856 are already in the "reforestation completed" class.

(3) How much of this abandoned farm land adjoins State Forests or lies near enough to the boundary so that the contiguous unit area

⁴ See Report of N. Y. Reforestation Commission, 1932.

requirement could be waived in favor of acquiring smaller tracts, being virtual additions to present State Forests? The district foresters of Pennsylvania were of great assistance in estimating these areas and others in their districts (See Table 2).

To answer the above questions a canvass was made of seventeen counties in Pennsylvania.

Methods of Canvass

The first step in the canvass was to secure Highway Department county maps giving townships and roads, or, where they could not be obtained, U. S. Geological Survey quadrangle sheets. On entering a county a list of all township assessors was secured. Members of the canvass worked singly. Each assessor was visited and his property lists reviewed, idle farms and portions of farms were listed and assessed values per acre secured. Where assessors were new or did not know their lands, other citizens having a thorough knowledge of land conditions were asked to furnish information. Ocular checks were made by the members of the survey. Three members covered a county in a week by working early and late.

The schedules used called for idle cleared land: Class I, with 500 acres or more in approximately contiguous tracts; Class II, and sized tracts of idle cleared land near present State Forests; Class III, small tracts scattered too much for State administration. Most attention was paid to abandoned and idle farm lands as these are the easiest to reforest successfully.

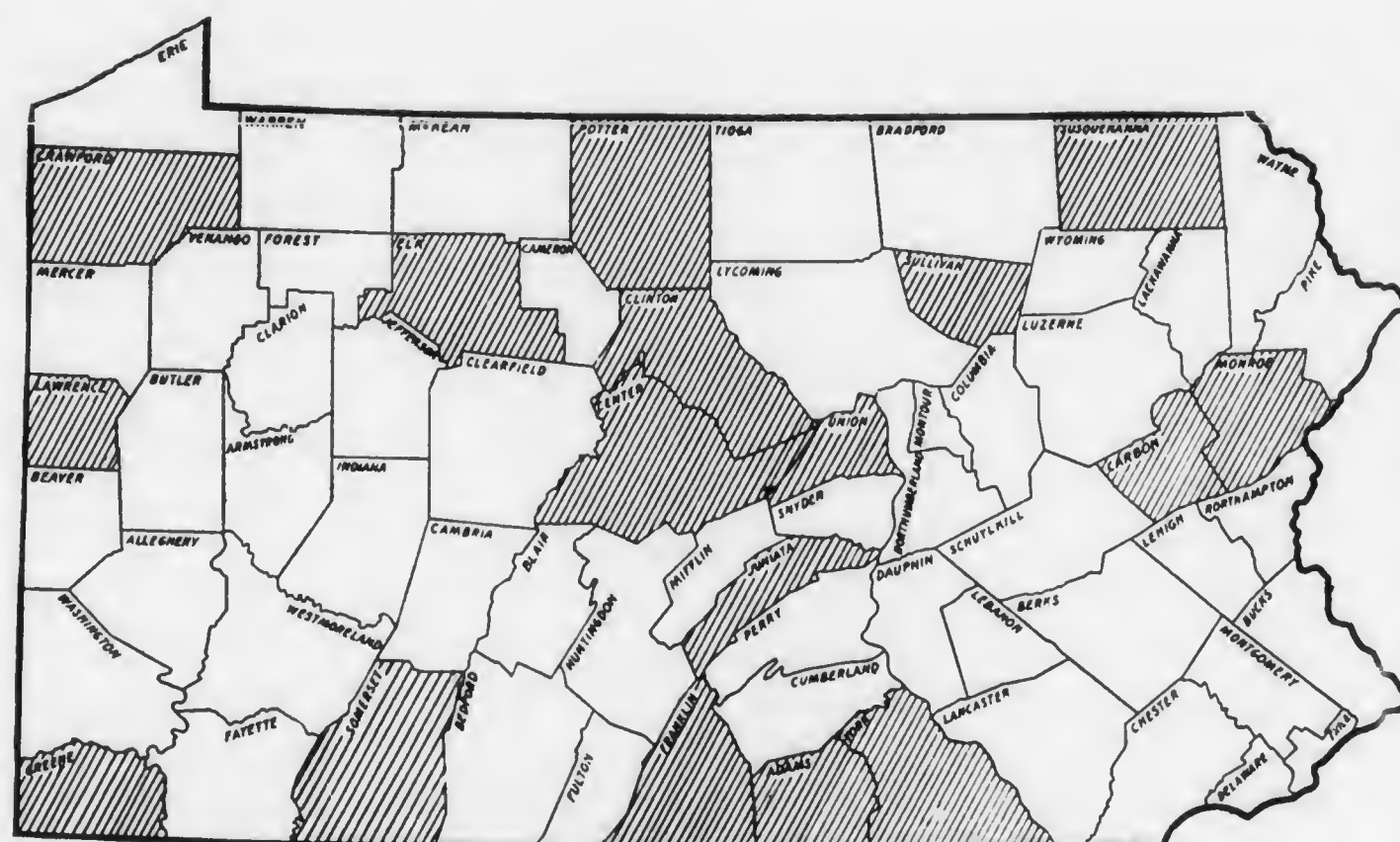


Figure 2. Counties canvassed in the idle land survey of Pennsylvania.

Counties Canvassed

Table 2 gives the seventeen counties canvassed and the accompanying map shows their location. In addition, the Greater Pennsylvania Council has promised similar data for Indiana, Jefferson, and several other counties. These data will be available before the end of this year, but cannot be incorporated in this report.

Idle Cleared Land Listed

The land listed as "idle" excludes all land grazed, though in many places the grazing value is far less than the timber producing value. In the counties canvassed the idle cleared land listed amounted to slightly over fifty per cent of the area suggested by the Census data. It is suspected that some of the discrepancy may lie in the census agents' and farmers' interpretation of "woodland" and that the farms have a larger amount of woodland grazed and not grazed that is not reported. The excluding of all land with even slight grazing use from the canvass totals also tends to make these totals very low. The difference is not consistent, however, the canvass showing more idle land in some forested counties, such as Clinton and Sullivan, than the Census, while in some predominantly agricultural counties, like York and Adams, only 25 to 30 per cent of the amount of idle land suggested by the Census could be readily located. The estimated total of 1,200,000 acres of idle cleared land is probably much below the mark. When reforestation values are once understood it is probable that this figure could be greatly increased for reforestation by adding land now grazed and farmed at a loss. The total reforestation problem is thus seen to be a huge one in the aggregate, which will require determined effort by the combined governmental and private agencies, including the State, counties, municipalities, farmers, mining companies, water and power companies, and others.

To produce trees to reforest upwards of 1,200,000 acres would require the output of our present State Forest nurseries for over 100 years (assuming an output of 12,000,000 trees annually).

Planting Trees Furnishes An Opportunity to Increase Conifers

In normal years the United States used five times as much softwood (pine, spruce, hemlock, fir, and redwood) as hardwood. General construction work calls largely for coniferous timber. In 1899, when Pennsylvania was at the peak of her lumber output, 77 per cent was softwood, and 23 per cent, hardwood. Since then, by axe and fire, we have changed our forest structure until in 1925 we were cutting only 40 per cent softwood and 60 per cent hardwood, and importing tremendous quantities of softwood to meet our structural needs.

Artificial reforestation will give the State an opportunity to reduce this great deficiency of softwood timber in its forests. Old fields do better in coniferous trees than in broadleaf trees. Reforesting these 1,200,000 acres of idle land largely to conifers should add to our lumber cut upwards of 600 million feet annually—for all of which and much more we have a home market.

TABLE 2 Idle Cleared Land Suitable for Reforestation (Found by Canvass of 17 Counties)

County	Loss In Non-Wood- Land Farm Area 1910- 1930 from U. S. Census	Idle Cleared Land Found by Canvass				Assessed Values			
		Total acres	In 500-Acre Blocks acres	Adjacent to State Forests acres	Scattered Small Areas acres	Idle Cleared Land			
						Aver- age \$	Mini- mum \$	Maxi- mum \$	
Adams	17,422	5,855	....	400	4,955	18.50	3.00	30.00	9.77
Carbon	15,994	4,717	.....	.....	4,717	14.14	3.50	40.00	4.58
Center	24,811	15,390	3,487	768	11,315	16.00	1.00	33.33	1.77
Clinton	9,982	12,244	430	5,401	6,413	16.00	1.00	60.00	2.58
Crawford	67,875	31,902	4,428	691	26,783	15.00	1.00	60.00	10.00
Elk	9,981	8,600	900	1,750	5,950	10.00	5.00	40.00	3.00
Franklin	14,411	8,393	.....	1,218	7,175	14.82	1.00	59.00	4.85
Greene	24,953	12,135	1,295	.....	10,840	10.00	5.00	30.00	.....
Juniata	15,317	8,990	.....	650	8,340	8.39	1.00	13.00	2.66
Lawrence	27,500	17,047	3,251	.....	13,796	30.00	3.63	64.00	.....
Monroe	29,140	24,767	.....	.....	23,962	15.16	1.90	38.00	6.04
Potter	55,498	23,470	610	805	17,100	7.50	2.00	13.00	3.00
Somerset	58,350	21,010	2,325	5,760	15,255	5.50	2.00	40.00	3.00
Sullivan	9,258	10,770	4,768	1,330	3,420	7.46	1.00	27.77	.....
Susquehanna	46,271	13,605	3,592	.....	10,013	14.79	3.35	60.00	.....
Union	6,356	4,000	500	425	3,075	18.84	3.00	50.00	.....
York	38,642	9,420	.....	.....	9,420	22.49	4.50	60.00	11.11
Total Sample	471,761	232,315	25,586	22,280	182,349	.....	.....	.....	.....
Estimate for State	^a 2,359,223	1,200,000	130,000	⁴ 42,000	1,028,000	.....	.....	.....	.....

¹ Center County contains at least 1300 acres of open forest land in Curtin and Ferguson Townships fit for planting.

² Elk contains much open forest land suitable for planting. Assessed values hold for tax sale lands.

³ Franklin County contains 2000 acres of open forest land in Greene, Lurgan, Montgomery, Southampton, and Warren Townships fit for planting.

⁴ The counties canvassed include approximately half of the State Forest lands; this is a larger sample than the general idle land sample, hence the total estimate of this class is only two times the area in the sample.

⁵ This becomes 3.8 million from 1880 to 1930, some of which has naturally succeeded to scrub forest.

Income and Expenditures

Examination of many successful coniferous old field plantings in Pennsylvania indicate that an annual growth and ultimate annual cut of 500 board feet per acre may be conservatively achieved in such reforestation. At the present average stumpage value of \$10.00 per thousand this would net \$5.00 per acre annually after cutting size is reached at about 60 years and up (pulp wood and other products would be cut much earlier). By selecting the large trees for cutting this \$5.00 income could be stabilized so that the forest would have an earning capital value of \$100 per acre at five per cent for a private owner's calculation, or \$167 per acre at three per cent for State ownership. With a thinning removal of 1/3 of the stand at 40 years (15 cords at \$2.00 stumpage) the present worth of such an investment would be about \$10.00 at five per cent and \$27.00 at three per cent compounded.

In other words to realize five per cent compound interest the private owner could invest about \$10.00 per acre in land and planting while the State at three per cent could successfully invest up to \$27.00 per acre. Herein is found the great financial advantage of State over private reforestation. Forestry is a long time investment and low interest rates are paramount.



White pines planted on the watershed of the city of Scranton. Each year this land is growing \$3 to \$5 worth of timber on the stump per acre. Its manufacture into lumber will create another \$5 to \$10 worth of labor per acre per year.

TABLE 2 Idle Cleared Land Suitable for Reforestation (Found by Canvass of 17 Counties)

County	Loss In Non-Wood-Land Farm Area 1910-1930 from U. S. Census	Idle Cleared Land Found by Canvass			Assessed Values			
		Total acres	In 500-Acre Blocks	Adjacent to State Forests acres	Scattered Small Areas acres	Idle Cleared Land		
						Average	Minimum	Maximum
	acres	acres	acres	acres	acres	%	\$	\$
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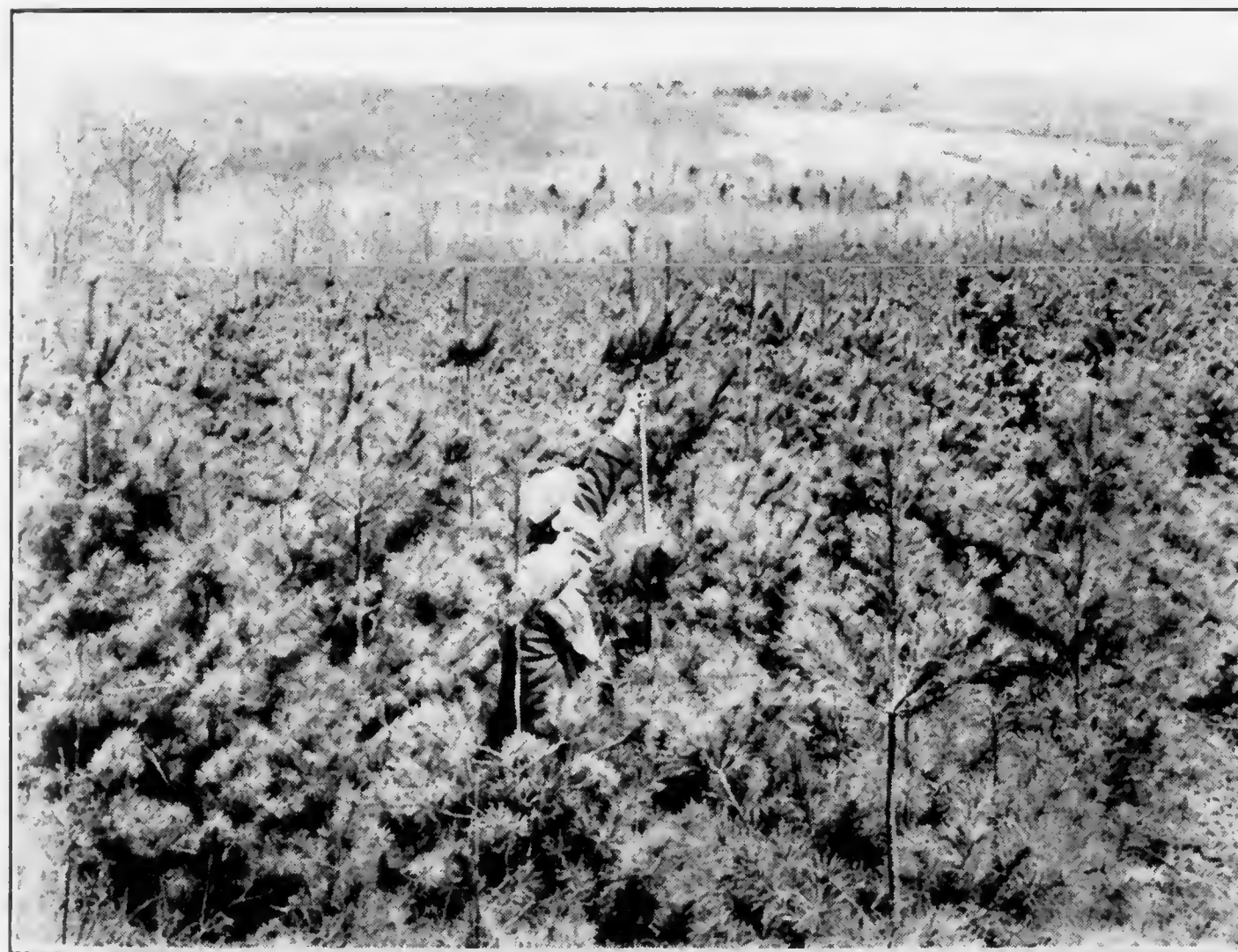
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White pines planted on the watershed of the city of Scranton. Each year this land is growing \$3 to \$5 worth of timber on the stump per acre. Its manufacture into lumber will create another \$5 to \$10 worth of labor per acre per year.

On the other hand the private owner already has the idle land which the State could purchase, and he is paying taxes on this land continually with no net return. From this point of view the private owner is investing only the planting cost of trees and his own labor. And for cost of supervision the private owner has the advantage of being able to look after his trees and protect them while doing other work on his property, and at little extra cost.

There are returns other than timber that must often enter the problem and they alone often affect the decision to reforest. A clear case in the water or power company protecting its reservoir from muddy water and silt. Here reforestation is a cheap method of securing these results and the timber product is a rich bonus. The same is true of many farms where side hill wash is coming down and ruining valuable fertile lower slope and bottom lands. Reforesting these upper slopes is essential in preserving the better lands and the timber product is again a bonus.

Areas for Which the State Should be Responsible

From the practical standpoint of protection and administration the State is limited to handling blocks of reforestation land of 400 or 500 acres and more, now immediately contiguous or near enough to build sometime into a contiguous holding. In purchasing idle cleared land, the State would acquire much forest land attached to these properties as well as much land not listed as idle but now farmed at a loss. The 130,000 acres of idle land listed in Table 2 as occurring in 500-acre blocks or larger may be taken, therefore, as only a beginning of this work. Undoubtedly 300,000 acres of all three classes (idle clear, attached forest, and submarginal grazing and farm land) will be available to the State for successful reforestation.

In addition idle clear land adjacent to present State Forests in any sized parcels can be handled by the State for reforestation since their protection and administration would add little to present organization overhead. Table 2 indicates 42,000 acres of cleared idle land adjacent to State Forests. Adding the forest lands attached to these idle clear lands would bring the total acreage of this class available for purchase up to 75,000 acres. Inferior grazing and farm lands not idle would increase this figure.

The total estimated lands feasible for State purchase and reforestation may then be summarized as follows:

	<i>Total Area</i>	<i>Area to be Planted (acres)</i>
(a) In 500-acre blocks at distance from State lands	300,000	200,000
(b) In smaller tracts adjacent to present State Forests	75,000	50,000
Total	375,000	250,000

This total is going to grow as more and more inferior farm lands are abandoned as hopeless for profitable farming. As shown in Table 1, this movement has gone on markedly and inexorably since 1880, and between 1925 and 1930 was proceeding at the rate of 100,000 acres per year.

Reforestation Must Again Establish a Balance

Reforestation, by taking up the slack in land use caused by a depressed agriculture and by increasing forest industries, must again tighten up the agricultural land use through improved local markets, and thus stop the abandonment of farms adjacent to the forest. The rapid gain in population and agriculture in Washington and Oregon has been made possible by the transfer of eastern forest industry to those states. Pennsylvania must win a portion of this industry back. It will help stabilize our agriculture again as well as our industries with a new supply of home grown raw materials, lumber, pulpwood, tanbark, mine props, railroad ties, poles, and the whole list of forest products that are now imported into the State.



A Scotch pine plantation in Pennsylvania, 19 years old. At this early age the trees may be thinned out. The cordwood removed is suitable for fuel.

Cost of Lands for Reforestation

Although Table 2 gives high average assessments for these idle lands, delinquent tax studies reveal that for this class of lands assessments are apt to be higher than full sale value. The minimum assessments are therefore a better guide to values, at least for the early purchases in a reforestation policy. It is believed that some years' purchases of this idle land with the accruing forest land may be carried out within the present \$10.00 limit. Whether this limit should later be raised could depend on the situation as it develops. At present such a raise would not be anticipated. On the other hand it is not believed

On the other hand the private owner already has the idle land which the State could purchase, and he is paying taxes on this land continually with no net return. From this point of view the private owner is investing only the planting cost of trees and his own labor. And for cost of supervision the private owner has the advantage of being able to look after his trees and protect them while doing other work on his property, and at little extra cost.

There are returns other than timber that must often enter the problem and they alone often affect the decision to reforest. A clear case in the water or power company protecting its reservoir from muddy water and silt. Here reforestation is a cheap method of securing these results and the timber product is a rich bonus. The same is true of many farms where side hill wash is coming down and ruining valuable fertile lower slope and bottom lands. Reforesting these upper slopes is essential in preserving the better lands and the timber product is again a bonus.

Areas for Which the State Should be Responsible

From the practical standpoint of protection and administration the State is limited to handling blocks of reforestation land of 400 or 500 acres and more, now immediately contiguous or near enough to build sometime into a contiguous holding. In purchasing idle cleared land, the State would acquire much forest land attached to these properties as well as much land not listed as idle but now farmed at a loss. The 130,000 acres of idle land listed in Table 2 as occurring in 500-acre blocks or larger may be taken, therefore, as only a beginning of this work. Undoubtedly 300,000 acres of all three classes (idle clear, attached forest, and submarginal grazing and farm land) will be available to the State for successful reforestation.

In addition idle clear land adjacent to present State Forests in any sized parcels can be handled by the State for reforestation since their protection and administration would add little to present organization overhead. Table 2 indicates 42,000 acres of cleared idle land adjacent to State Forests. Adding the forest lands attached to these idle clear lands would bring the total acreage of this class available for purchase up to 75,000 acres. Inferior grazing and farm lands not idle would increase this figure.

The total estimated lands feasible for State purchase and reforestation may then be summarized as follows:

	<i>Total Area</i>	<i>Area to be Planted (acres)</i>
(a) In 500-acre blocks at distance from State lands	300,000	200,000
(b) In smaller tracts adjacent to present State Forests	75,000	50,000
Total	375,000	250,000

This total is going to grow as more and more inferior farm lands are abandoned as hopeless for profitable farming. As shown in Table 1, this movement has gone on markedly and inexorably since 1880 and between 1925 and 1930 was proceeding at the rate of 100,000 acres per year.

Reforestation Must Again Establish a Balance

Reforestation, by taking up the slack in land use caused by a depressed agriculture and by increasing forest industries, must again tighten up the agricultural land use through improved local markets, and thus stop the abandonment of farms adjacent to the forest. The rapid gain in population and agriculture in Washington and Oregon has been made possible by the transfer of eastern forest industry to those states. Pennsylvania must win a portion of this industry back. It will help stabilize our agriculture again as well as our industries with a new supply of home grown raw materials, lumber, pulpwood, tanbark, mine props, railroad ties, poles, and the whole list of forest products that are now imported into the State.



A Scotch pine plantation in Pennsylvania, 19 years old. At this early age the trees may be thinned out. The cordwood removed is suitable for fuel.

Cost of Lands for Reforestation

Although Table 2 gives high average assessments for these idle lands, delinquent tax studies reveal that for this class of lands assessments are apt to be higher than full sale value. The minimum assessments are therefore a better guide to values, at least for the early purchases in a reforestation policy. It is believed that some years' purchases of this idle land with the accruing forest land may be carried out within the present \$10.00 limit. Whether this limit should later be raised could depend on the situation as it develops. At present such a raise would not be anticipated. On the other hand it is not believed

that this land can be acquired as cheaply in Pennsylvania as in New York, where in 1930 and 1931 or during the first two years of operation of the reforestation plan, almost 80,000 acres of reforestation land (clear and accruing forest) were purchased at a rate averaging \$3.75 per acre.

Planting Expenditure and Emergency Labor

The cost of trees (2- and 3-year seedlings and 2-2 transplants) would average about \$3.00 per thousand. Planting 1,200 trees per acre (6 x 6 foot spacing) would cost for trees \$3.60 per acre, and planting labor (at \$.20 per hour, 400 trees per man per day) \$6.00, or a total of \$9.60 per acre. This would practically all be payment to labor since the nursery costs are almost all labor. Such a project would enable the State to expend emergency relief funds as an investment that would come back with interest, and improve the State's economic condition permanently. A reforestation project (self-liquidating) could be worked out for part financing by the U. S. Reconstruction Finance Corporation, and many idle workers given productive work.



A tree planting crew in Clinton County.

A State Reforestation Policy

Forest trees for reforestation cannot be grown in a month. The smallest planting stock used should be 2- and 3-year seedlings for the best sites, and 2-2 transplants for more difficult sites. This requires nursery planning and a reforestation plan for, say, ten years, since our present nursery output is not over 12 million trees. For this reason the policy should start in a small way, not over 10,000 acres purchased the first year, and then increased to 15, 20, and 25 thousand acres per year for succeeding years. This would call for the purchase of 25,000 acres the first biennium, which should require an appropriation as follows:

25,000 acres (including some attached forest) @ \$6.00	\$150,000
15,000 acres planting labor @ \$6.00	90,000
18,000,000 trees @ \$3.00 per M nursery costs	54,000
Total	\$294,000

The second biennium this would increase 40 per cent of the total if 35,000 acres were to be secured and a proportionate amount reforested. The policy could then continue at this rate.

Demonstration Reforestation

Since over a million acres of this idle land is so scattered that the State could not administer it, counties, municipalities, corporations, and private individuals should be encouraged to join the movement. State (or Federal Reconstruction Finance Corporation during the emergency) aid could be provided for counties on a 50-50 basis with aid limited to \$5,000 to any one county in a year. A sum of \$100,000 might be made initially available as relief money earmarked for county reforestation projects.

A most important step would be the locating of the first State reforestation as demonstration reforestation projects along highways in each county. This would educate private owners in the methods and results of reforestation as no other method could. After all the reforestation problem is in largest part a private land owner's problem and the State can only blaze the way with demonstration plantings and assist with forest seedlings and transplants at cost, and with the supervisory assistance of its trained foresters.

Effect on Local Finances

The effect of State purchase of these idle lands for reforestation may appear to be seriously diminishing the tax income in such townships where the lands might be concentrated. There should be no such effect, however, since these lands are the ones from which the considerable areas of tax delinquencies and tax sales are now springing. It would be better to have a certain, though small, State payment than no tax return.

It is also believed that some increase in State payments on State lands in lieu of taxes will be recommended to the legislature. In extreme cases the land purchase may enable unprofitable schools to be closed and the few owners to be settled on better lands in stronger communities. In the long run land put to its most profitable use will pay the most to the cost of government.

In isolated sections such State leadership in reforestation would permit cooperation with local school boards and road supervisors, in acquiring scattered submarginal farms and relocating the families to their own advantage. This would permit closing of uneconomic schools, shorten school transportation routes, and vacate miles of township roads. It would permit the merging of townships and encourage economy in the cost of government.

Clinton County is a striking example where a detailed study of township merging should prove fruitful in governmental economies if coupled with a State and county policy of reforestation of idle and submarginal cleared lands. Many other counties have similar situations. Several forest and farm townships in Clinton have less than 300 acres of active farm land each, and no industries.

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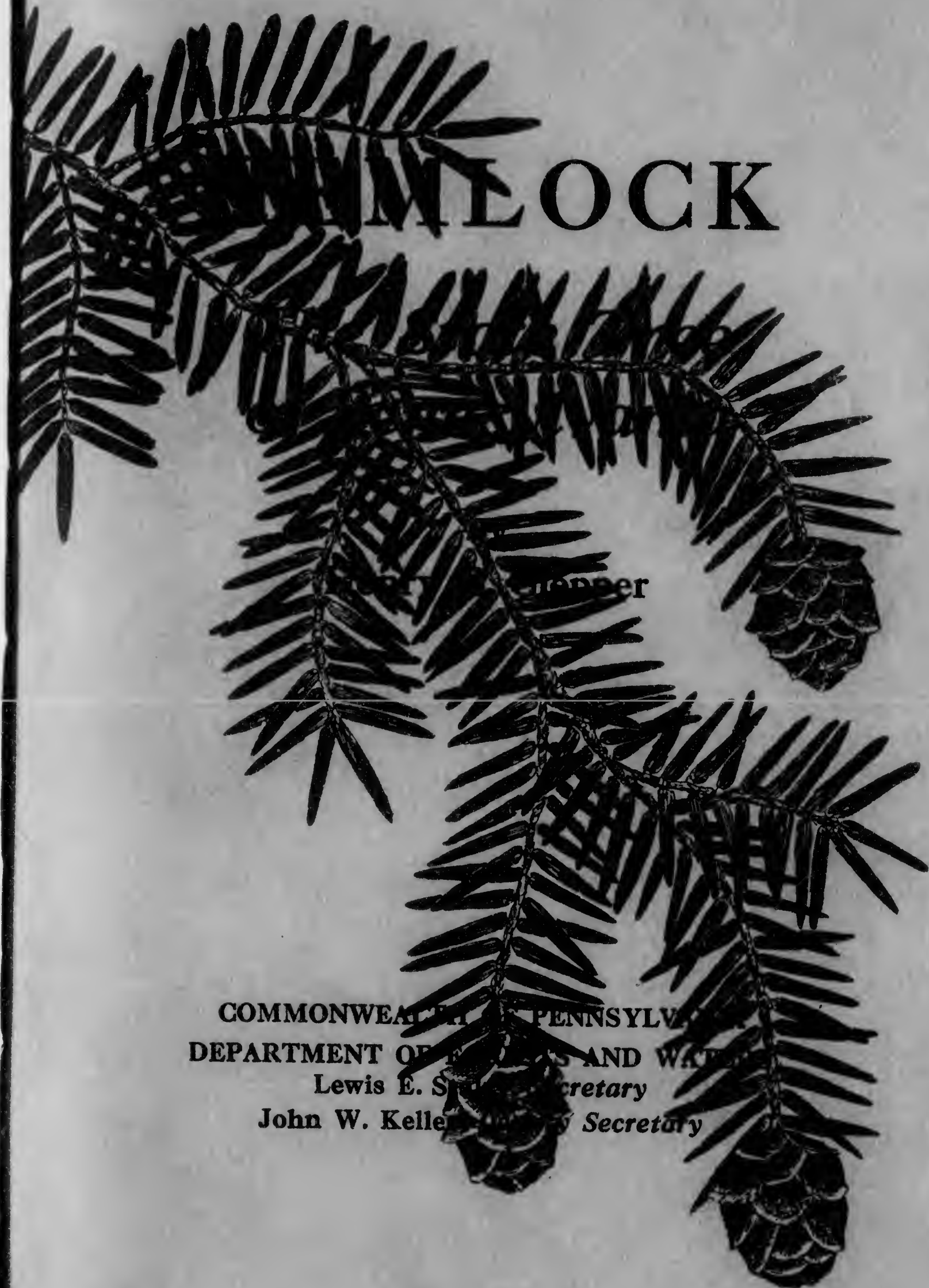
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SUMMARY

- (1) Pennsylvania has upward of four million acres that are now practically idle, or about one-seventh of the whole State area. Of this, over two million acres are idle cleared farm land.
- (2) This idle land, coupled with poor land now farmed at a loss, is causing a rapid increase of tax delinquency and tax sales. "Idle lands pay no taxes."
- (3) Agriculture is over-developed. We grow more farm crops than the market can absorb, except at "dumping prices."
- (4) Forest consumption still outruns forest growth by over 40 per cent in the United States. In Pennsylvania alone we grow less than 16 per cent of our lumber used. We import from other sections about \$100,000,000 worth of forest products during normal years.
- (5) *Reforestation Pennsylvania's idle land is a self-liquidating public work.* It is the duty of the State to assume the leadership in reforesting this idle land. Twenty-five thousand acres should be purchased and 15,000 acres planted to forest trees during the next biennium. In succeeding bienniums this program should be doubled, as planting stock would then be available.
- (6) Counties and municipalities should be encouraged to take part in the movement by a 50 per cent contribution from the State.
- (7) The first biennium would require an appropriation of \$294,000 for State purchase and reforestation of idle land. To this should be added \$100,000 for county and municipal aid reforestation projects.
- (8) *At least half of the expenditure, and possibly two-thirds (depending on the cost of lands), would go directly into emergency labor.* The rest would represent land purchase.
- (9) This policy would in years to come support some of our present industries, and ultimately bring back some that we have lost. With a small initial investment of not over \$12 per acre and an annual cost of 20c. per acre, a capital value of \$100 to \$300 per acre would be built up—a satisfactory return to the State even with a compound interest requirement.
- (10) France has reforested a large waste land area with excellent financial returns. New York State has pledged \$1,000,000 a year for the next twenty years to redeem its idle lands and its forest industries in the same project.
- (11) Our farm prosperity declined with our forest industry. In large parts of the State they will go forward together, especially where the mountain farms will fail without winter work in the forests for the farmers.
- (12) A ten-year plan should be initiated so that the requisite planting stock could be ready each year, and definite progress outlined

no. 52



MELOCK

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATER
Lewis E. Spang Secretary
John W. Keller Secretary

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NO. 52

HEMLOCK

*The State Tree
of Pennsylvania*

By
Henry E. Clepper

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS
Lewis E. Staley, Secretary
John W. Keller, Deputy Secretary

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[Bulletin 52]

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DEPARTMENT OF FORESTS AND WATERS

Lewis E. Staley, *Secretary*
John W. Keller, *Deputy Secretary*

Harrisburg
1934



HEMLOCK
THE STATE TREE OF PENNSYLVANIA

FOREWORD

France has her *fleur de lis*. Scotland has the thistle. Ireland has its shamrock. And now Pennsylvania, its hemlock.

Pennsylvania, the only State embodying the idea of trees and forests in its name—Penn's Woods—has acquired by an act of legislature something that few States possess. And that is a State Tree.

The hemlock legally and officially became the State Tree of Pennsylvania on June 22, 1931, and the act declaring it such was approved by a governor whose name for considerably more than a quarter-century has been intimately associated with the conservation of trees and forests in this country—Gifford Pinchot.

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LEWIS E. STALEY

AN ACT. No. 233

Declaring and adopting the hemlock (Tsuga Canadensis Linnaeus) as the State tree of Pennsylvania.

Whereas, The hemlock (*Tsuga Canadensis* Linnaeus) is still today, as it was of old, the tree most typical of the forests of Pennsylvania; and

Whereas, The hemlock yielded to our pioneers the wood from which they wrought their cabin homes; and

Whereas, The hemlock gave its bark to found a mighty industry; and

Whereas, The hemlock everywhere lends kindly shelter and sure haven to the wild things of forests; and

Whereas, The lighted hemlock at Christmas time dazzles the bright eyes of the child with an unguessed hope, and bears to the aged, in its leaves of evergreen, a sign and symbol of faith in immortality; now therefore,

Section 1. Be it enacted, &c., That the hemlock tree (*Tsuga Canadensis* Linnaeus) be adopted as the State tree of Pennsylvania.

APPROVED—The 22d day of June, A. D. 1931.

Jeffrey P. Nichol

AN IMPORTANT TREE FAMILY

The hemlock is a member of the pine family, whose scientific name is *Pinaceae*, one of the most important groups of trees in the world, especially on account of the economic importance and value of their many commercial products, such as lumber, naval stores, fuel, food (from the nuts of certain species), chemicals, pulp for paper, and a hundred other useful articles.

Commonly known as conifers because the fruit is a cone, the trees of this family are characterized by bearing a certain kind of leaves, called needles, which do not fall to the ground each year when winter comes as do the leaves of many other kinds of trees. They are therefore called evergreens, though this name is not, strictly speaking, correct, for the larches, which are also members of this great family, are deciduous trees, that is, they drop their needles each winter and grow a new crop in the spring. Another name given to the trees of the pine family is softwoods, but this name also is inexact, for the wood of many species is actually harder than the wood of some of the so-called hardwoods, such as poplar and basswood, which are in turn frequently called broad-leaf trees to distinguish them from the needle-leaved trees.

All this may appear very confusing to one attempting for the first time to gain some knowledge of trees, but since we are discussing the hemlock primarily, the principal facts to remember are that it belongs to the great pine family, it is an evergreen with needle-shaped leaves, its wood is classed with the softwoods, and it is a conifer.

It may be interesting to know further that some of the other common tree members of this family are the pines, the larches, the spruces, the firs, the cedars, and the junipers. The pines comprise by far the most important genus, whence the name of the family.

Because it is so common throughout Pennsylvania, and because of its beauty among the hundred and more species of trees found within our borders, and because it is an outstanding tree of our forests, the hemlock is most worthy of the distinction of being our State Tree.

WHERE THE HEMLOCKS GROW

Trees of the northern hemisphere and the temperate zone, the hemlocks comprise nine species, four of which are native to North America and the others to Japan, China, and the Himalaya Mountains between India and Tibet. Europe has no native hemlocks. From discoveries of traces of what are believed to be extinct species found in the Jurassic rocks of Spitzbergen, northern Europe, and Siberia, hemlocks apparently were far more important in the composition of ancient northern forests than they are in the present age.

Of the North American hemlocks two species grow in the western part of the United States and two in the East. Only one of the two eastern species grows in Pennsylvania, and that one is our State Tree.

The range of this hemlock, however, is by no means confined to Pennsylvania. It is found growing from Nova Scotia on the North, westward for fifteen hundred miles to Minnesota, and southward along the mountains to northern Georgia and Alabama.

Greatly liking cool, moist habitats, hemlocks were once found growing in dense forests in the central and northern parts of the State, but now, on

account of the fires that followed lumbering, they are more limited to the slopes of rocky gorges, and along the banks of streams, lakes, and swamps. They may be seen frequently clinging to the crevices and faces of rocky ravines whose declivities are kept perpetually moist by springs, and where forest fires can not destroy them.

In northern Pennsylvania the most common tree neighbors of the hemlock are white pine, beech, yellow birch, and the maples. In the southern part of the State its associates are yellow poplar, red maple, the hickories, the oaks, and chestnut.

NAMES OF THE HEMLOCKS

Each of the nine species of hemlocks has a scientific, or Latin, name as well as a common name. Even though one may not wish to memorize the names of the hemlocks it is interesting to know what they are, if only to understand to what a far-flung family our State Tree belongs.

ASIATIC HEMLOCKS

Japanese Species

Japanese hemlock—*Tsuga Sieboldii* Carriere. Named by Elie Abel Carriere (1816-1896) in honor of Philipp Franz von Siebold (1796-1866).

Japanese hemlock—*Tsuga diversifolia* Masters. Named by Maxwell Tylden Masters (1833-1907); means variable-leaved.

Chinese Species

Chinese hemlock—*Tsuga chinensis* Pritzl. Named by George August Pritzl, a contemporary botanist, for its native land.

Western China hemlock—*Tsuga yunnanensis* Masters. So named because it grows in Yunnan Province, Western China.

Himalayan hemlock—*Tsuga dumosa* Sargent. Named by Charles Sprague Sargent, noted dendrologist; means bushy.

NORTH AMERICAN HEMLOCKS

Western Species

Mountain hemlock—*Tsuga Mertensiana* Sargent. Named for Mertens, a German botanist.

Western hemlock—*Tsuga heterophylla* Sargent. Name means various-leaved.

Eastern Species

Carolina hemlock—*Tsuga caroliniana* Engelman. Named by George Engelman (1809-1884); means native to the Carolinas.

Eastern hemlock, the State Tree of Pennsylvania,—*Tsuga canadensis* (Linnaeus) Carriere. Means native to Canada.

No one knows exactly where or how the hemlock got its name. The syllable "lock" and its derivatives, probably meaning plant, are common enough in botany, as in the cases of charlock, garlic, and barley. The origin of the first syllable "hem" has not been explained.



A HEMLOCK BORDERED STREAM IN THE POCONO MOUNTAINS OF MONROE COUNTY

The Latin or scientific names of the trees come from two sources. The word *Tsuga*, the name of the genus, is derived from the Japanese vernacular and was first used by Stephen L. Endlicher, a dendrologist, in 1847 to designate a section in the genus *Pinus*; its meaning is unknown. The species names are intended to be descriptive of the particular tree, or named for the locality where first found, or the discoverer, or in honor of some one.

Locally the hemlock may have more than one common name, which in the absence of a scientific name that is always uniform might, and often does, lead to confusion. For example, our State Tree is called hemlock, hemlock spruce, spruce-pine, and eastern hemlock. In Canada it is known as white hemlock and Canadian hemlock. The German name for hemlock is Schierling Tanne.

The English call it hemlock-spruce and hemlock fir. The French-Canadians have several names for it; Peruche, tsuga du Canada, and sapin du Canada. To the French it is Perusse. The American Indians knew the hemlock by the name oh-ne-tah, meaning "greens on the stick."

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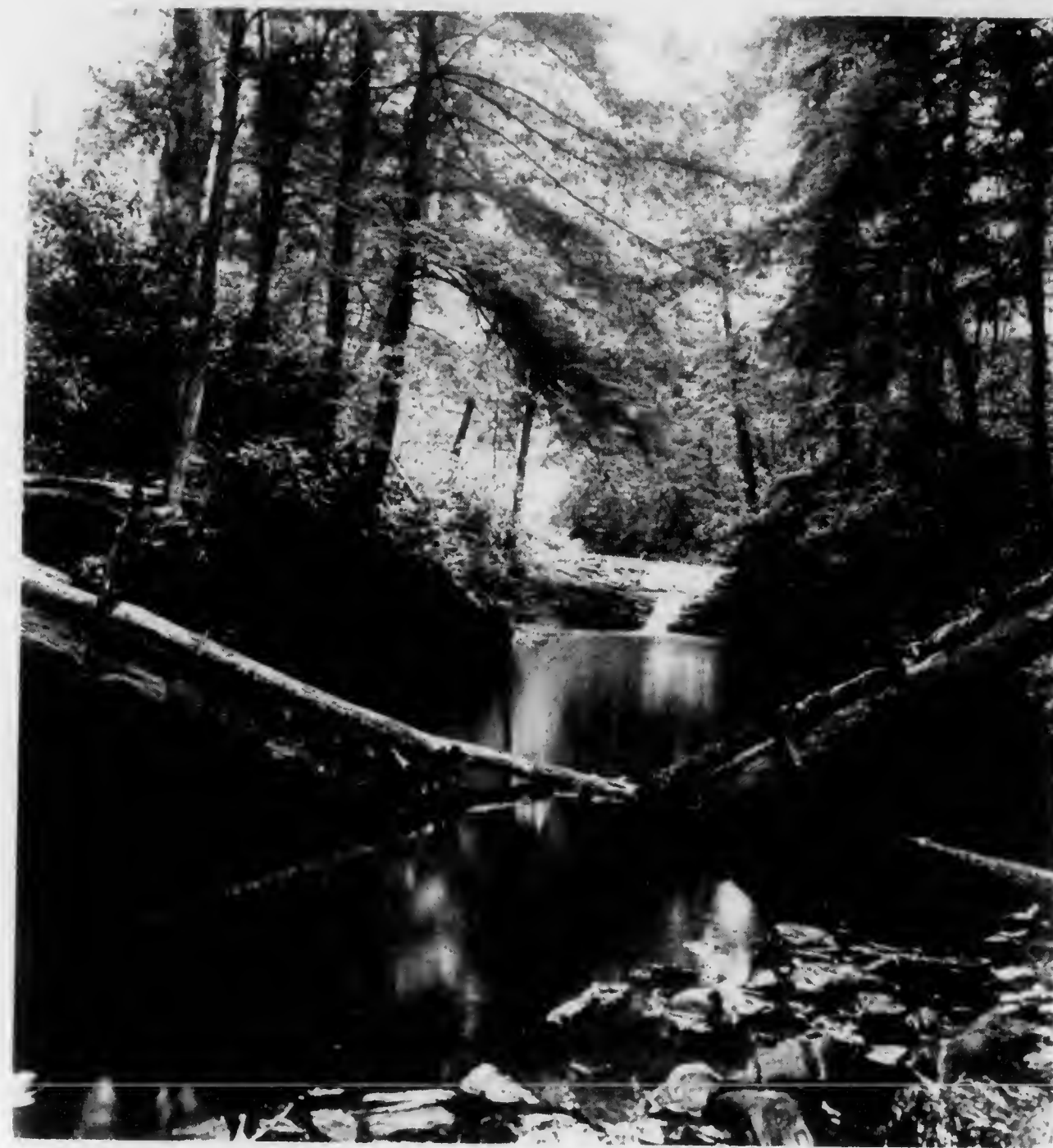
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by the names Toga-mastu, Kome-tsuga, and Kuro-tsuga. The Chinese know the hemlock as Tieh Sha which means iron-fir.

One other evergreen growing naturally in the East is called hemlock. It is the American yew or ground hemlock, a small shrub rarely exceeding six feet in height whose fruit is not a cone, but an aromatic scarlet berry, botanically known as an aril.

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CHARACTERISTICS OF THE HEMLOCK

Size

Full grown hemlocks attain heights of about 75 feet in Pennsylvania, though they may become as high as 125 feet. Their diameters vary from 2 to 3 feet at breast height (4½ feet above the ground). Very old trees growing in good soil have reached dimensions of 160 feet in height and 5 to 6 feet in diameter measured at breast height, though trees this size are rare.

Trees that yielded 10,000 board feet of lumber are reported to have been cut in West Virginia, but there is no record of a hemlock so huge ever having been felled in Pennsylvania. One with a content of 5,000 board feet would be considered extremely large. Foresters have measured the volume of many standing hemlocks in various parts of the country, and have found that a sound specimen 100 feet tall and 3 feet in diameter at breast height contains slightly more than 1,500 board feet.

Age

Several trees native to Pennsylvania attain great ages, and hemlock is one of them. Dr. Joseph T. Rothrock, the father of forestry in Pennsylvania, once counted the annual rings on a stump that measured four feet and ten inches in diameter. When cut the tree was 542 years old and must have been a vigorous, well grown specimen when Columbus first sighted the islands of the New World. An age of 500 to 600 years is probably exceptional, though that is the age that would correspond to a tree sufficiently large to yield 10,000 board feet of lumber.

Trees 250 years old are less rare, though there are very few remaining tracts of timber in Pennsylvania where hemlocks so old may be found. The Cook Forest Park in Jefferson County contains a stand of virgin hemlock, as does also the Allegheny National Forest in Warren County, and the Hemlocks State Forest Park in Perry County in the Tuscarora State Forest.

Although the size of a tree is usually a good indication of its age, this rule does not always hold good. For example, foresters have actually measured hemlocks 200 years old that varied in height from a minimum of 30 feet to a maximum of 130 feet with diameter from 5 inches to 40 inches.

Wood

The heartwood is light brown in color; the sapwood is buff with a brownish tinge. It has a handsome figure when stained and waxed or polished.

The wood is not strong, but it is hard, light in weight, stiff, and brittle. Its defects are that it is splintery, cross-grained, and not durable in contact with soil. A cubic foot of dry hemlock wood weighs slightly more than 26 pounds.

Bark

There are two distinct layers of bark; the inner bark is rather thin, white, and fibrous, and the outer bark is thick, reddish-brown, brittle, and scaly.

The thickness varies between one-half inch on young trees to as much as 2 to 3 inches on old ones. A characteristic of hemlock bark is that it breaks into long longitudinal fissures between which are broader ridges of loose flakes which easily become detached.

It is interesting to know that the bark of old trees comprises as much as 15 to 19 per cent of the total cubic volume of the tree. Because it is rich in tannic acid, a product important in the leather tanning industry, the bark is valuable commercially, and in fact was at one time worth more than the wood.



THREE SISTERS: TWO GIANT HEMLOCKS AND A WHITE PINE

Roots

Although seedlings form tap-roots during their first year, they later develop dense fibrous root systems that spread in all directions, commonly for long distances to obtain moisture.

Hemlock is ordinarily a shallow-rooted tree and can thrive on very thin soil. Where the soil is deep and loamy, however, the roots often penetrate far into the ground. Because of its shallow root system the hemlock is not very wind-firm.

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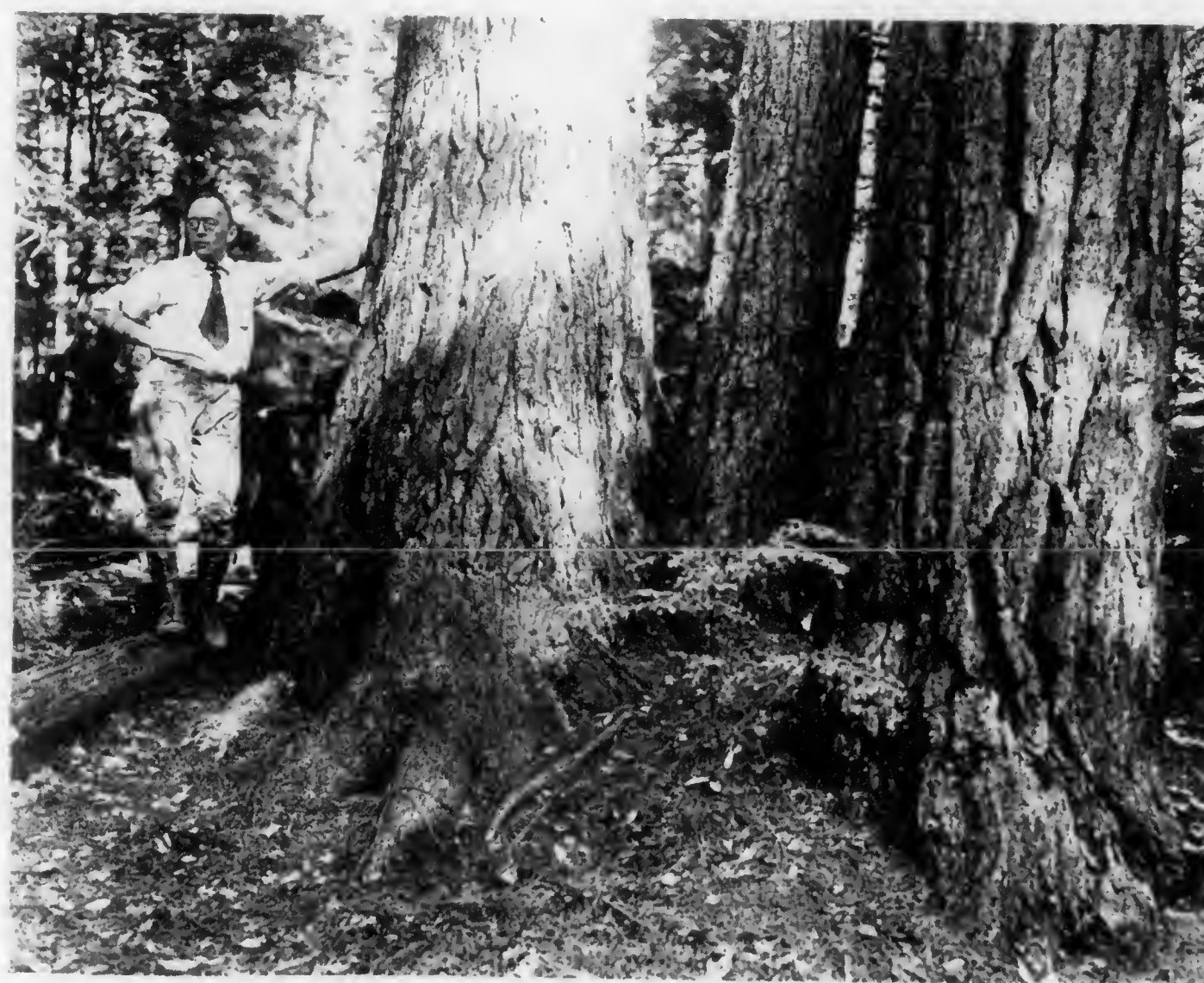
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Leaves

The leaves or needles are about one-half inch long, dark green above and light green on the under surface where two white parallel lines of stomata, or breathing places, are located. They are flat, narrow, rounded at the tip, and at the base are joined to very small woody stalks. Although the foliage is evergreen, individual leaves fall during their third year.

Cones

The flowers appear in May. The male or staminate flower is round and yellow, about one-quarter inch long. The female or pistillate flower, after fertilization, grows rapidly during the summer and by October it has become the ripened fruit—a cone.

Pale green while ripening, the cones later become dark brown. They are three-quarters of an inch long and about half as broad; when the cones dry and the scales expand they are as broad as long. They usually hang on the branches of the tree during the first winter.

It is interesting to observe how Nature provides for the dissemination of the seed. The cones are very sensitive to fluctuations in moisture. A little rain or snow causes the scales to close, and even if water does not come in contact with them they may close after an increase in the humidity of the air.

Each seed has a delicate and semi-transparent wing, which clings to the inner surface of the cone scale and which does not permit the seed easily to fall out of the cone. Dry air causes the scales to open and a few seeds may drop out, after which a change in moisture may cause them to close again. As the alternating opening and closing of the scales continue a few seeds are released, and, if the wind blows from several points, each time the winged seeds are blown about they are scattered in different directions. Thus Nature provides for the seeds from one tree to be sown over wide areas.

Seed

A hemlock seed is about one-sixteenth of an inch in length. Its wing is about one-quarter of an inch long and one-eighth of an inch broad. The function of the wing, as might be supposed, is to act as a sort of sail or kite to carry the seed for long distances in the wind. Some idea of the minuteness of the hemlock seed may be gathered from the fact that when cleaned and without the wings there are 400,000 of them to a pound.

Although a prolific seed bearer, the hemlock reproduces poorly. The seeds are slow to germinate in ground where forest fires have recently burned, but in the rich humus of the protected forest they come up under the shade of larger trees in great numbers.

When bountiful seed crops are borne by the hemlocks, which occur about every third year, foresters and rangers in Pennsylvania go into the woods and gather many bushels of cones. These are taken to seed extracting stations where the cones are placed in racks to dry. When the cones open the seeds are shaken out. As much as two hundred pounds of hemlock seed may be collected in a good seed year, and sowed in the forest tree nurseries where seedlings and transplants are raised by the Pennsylvania Department of Forests and Waters for reforesting idle land in the State.

Foresters, however, are not the only gatherers of hemlock seed. The red squirrel uses the hemlock as a source of food supplies, and his activities during the winter months account for many a tiny seed. How diligent they are at collecting the seeds may be seen by observing the cone scales on the snow at the foot of a fruitful hemlock.

PRODUCTS OF THE HEMLOCK

Lumber

There are other kinds of softwood trees in Pennsylvania, such as white pine, that yield a better grade of lumber than hemlock, but as the supply of timber from these species decreases, and it has been decreasing for years, hemlock has been finding larger markets. During the period when Pennsylvania ranked as one of the leading lumber producing states, from the time of the Civil War until 1875, hemlock had so little value in competition with better woods that it could not even be cut at the sawmill and shipped to the buyer except at a loss.

Beginning about fifty years ago the best grades of hemlock lumber were sold at a profit, and later the poorer grades began to have value in the manufacture of boxes and for rough construction where the better softwoods were not required. In 1899, a banner year for lumbering in Pennsylvania, the cut of hemlock comprised more than one and one-half billion board feet, or two-thirds of the entire lumber production. Unfortunately, considerable waste accompanies the sawing of hemlock at the mill, and for many years this waste material—slabs and unsound wood principally—was burned to get rid of it. As lumber gradually became more salable these slabs and other waste pieces were worked up into lath, or sold for conversion into paper pulp.

Hemlock has a great variety of uses, especially where great strength and durability are not essential. It makes good building and construction material, and is especially well adapted for frame work, weather boarding, roofing, floor lining, and laths. The wood has a few other minor uses, such as for railroad ties, shingles, and interior finishing. A characteristic of the wood that is greatly in its favor is the fact that it holds nails and spikes very well.

A useful wood where stiffness is desired without yielding, or elasticity, hemlock was used extensively for the threshing floors of barns, and, in the early part of the 19th century, in the larger Atlantic Coast cities as a substitute for stone in street paving after it was treated to resist decay. Paving blocks were sawn eight inches thick and eight to eighteen inches broad.

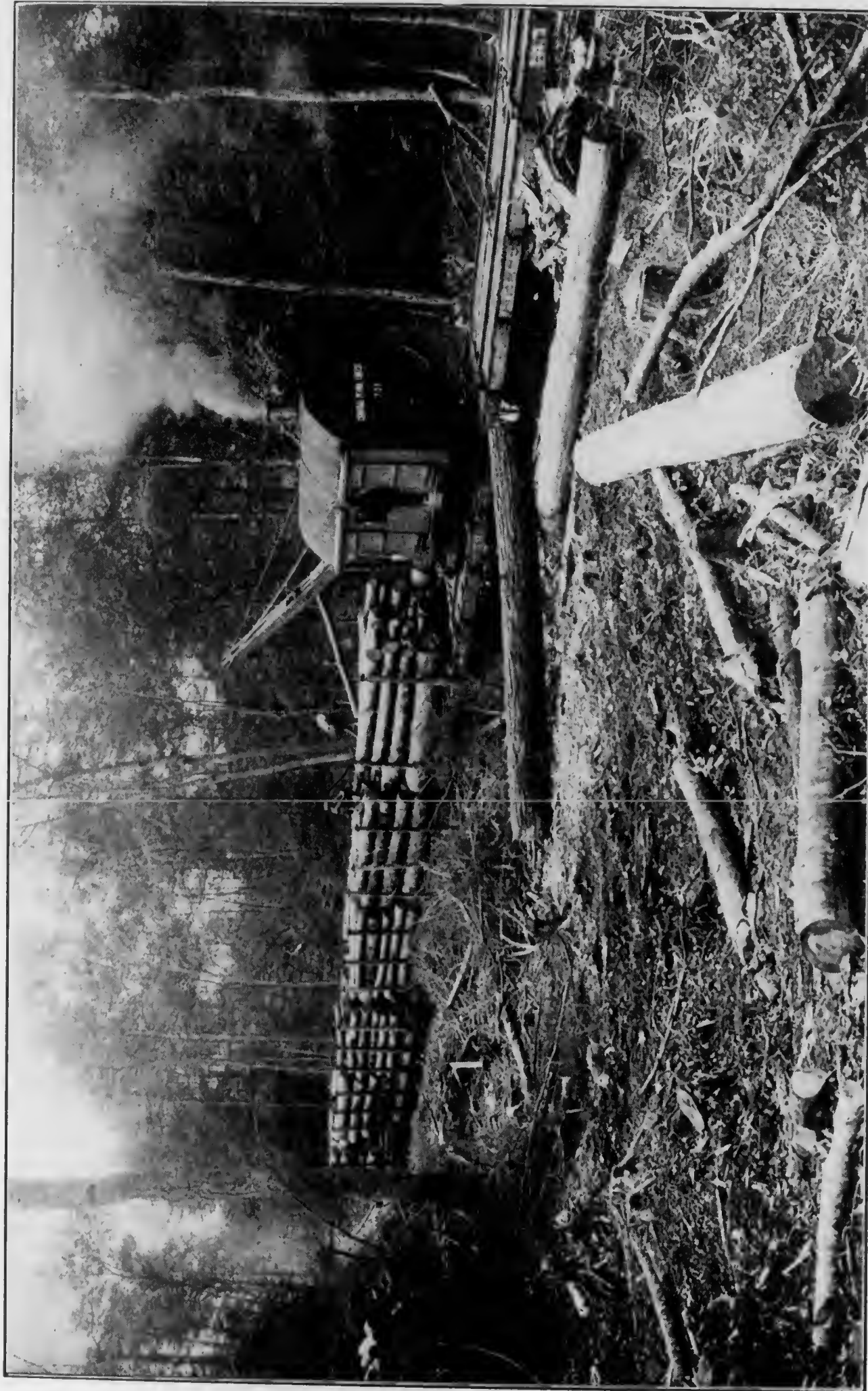
The fuel value of hemlock is low, which makes it less suitable than many other species, especially in open fireplaces where it burns with great crackling and snapping.

Land heavily timbered with hemlock yielded 25,000 board feet to an acre, though the average was from 15,000 to 20,000 board feet per acre.

Tanning

The bark of the hemlock has been used for tanning leather ever since the industry was started in this country. Pennsylvania has always been one of the leading states in the production of tan bark. No other tree has bark so high in tannin content, not even the chestnut oak, or rock oak, also a native of this State whose bark is important in the leather tanning industry. The method by which the bark is removed from the hemlocks and the wasteful system which prevailed for so many years make an interesting chapter in the history of Pennsylvania forest industries.

Trees are felled for tan bark in the late spring and summer only, usually from May to August, when the bark "slips" or peels most readily. The logs are girdled at four-foot intervals all the way from the butt to near



HEMLOCK AND OTHER KINDS OF LOGS ON THEIR WAY FROM THE WOODS TO THE SAWMILL. A LUMBERING OPERATION IN SULLIVAN COUNTY

the top. The bark is then peeled off in rectangular sheets with a special tool known as a "spud" and, after being loosely scattered or stood on end to permit rapid drying, it is later stacked in four-foot piles and measured by the cord, which is 4 feet wide, 4 feet high, and 8 feet long. At the tanneries the hemlock bark is usually mixed with oak bark in as much as the hemlock bark alone produces an objectionable bright red color in the leather, which the oak bark darkens.

In the early days of the lumbering industry in Pennsylvania so valuable was the hemlock bark and so little was the worth of the hemlock lumber that it was a common practice for the lumbermen to peel off the bark and let the logs lie in the woods to rot. As a result millions of feet of the finest kind of virgin hemlock timber have gone to waste on the mountain-sides of Pennsylvania and neighboring states. The 1900 census reported that in the previous year more than 330,000 cords of hemlock bark were produced in Pennsylvania.

Before synthetic dyes attained their present high state of perfection, hemlock bark was used in dye works to make a certain shade of brown. The use of hemlock for this purpose is not new, however, for the Indians used hemlock dye for many purposes, such as to dye the splints of their maple baskets.

Pulp

Considerable hemlock wood is now used for the manufacture of paper pulp. Though inferior to woods such as spruce and aspen, hemlock makes fairly good grades of newspaper, as well as wrapping paper and other cheaper kinds.

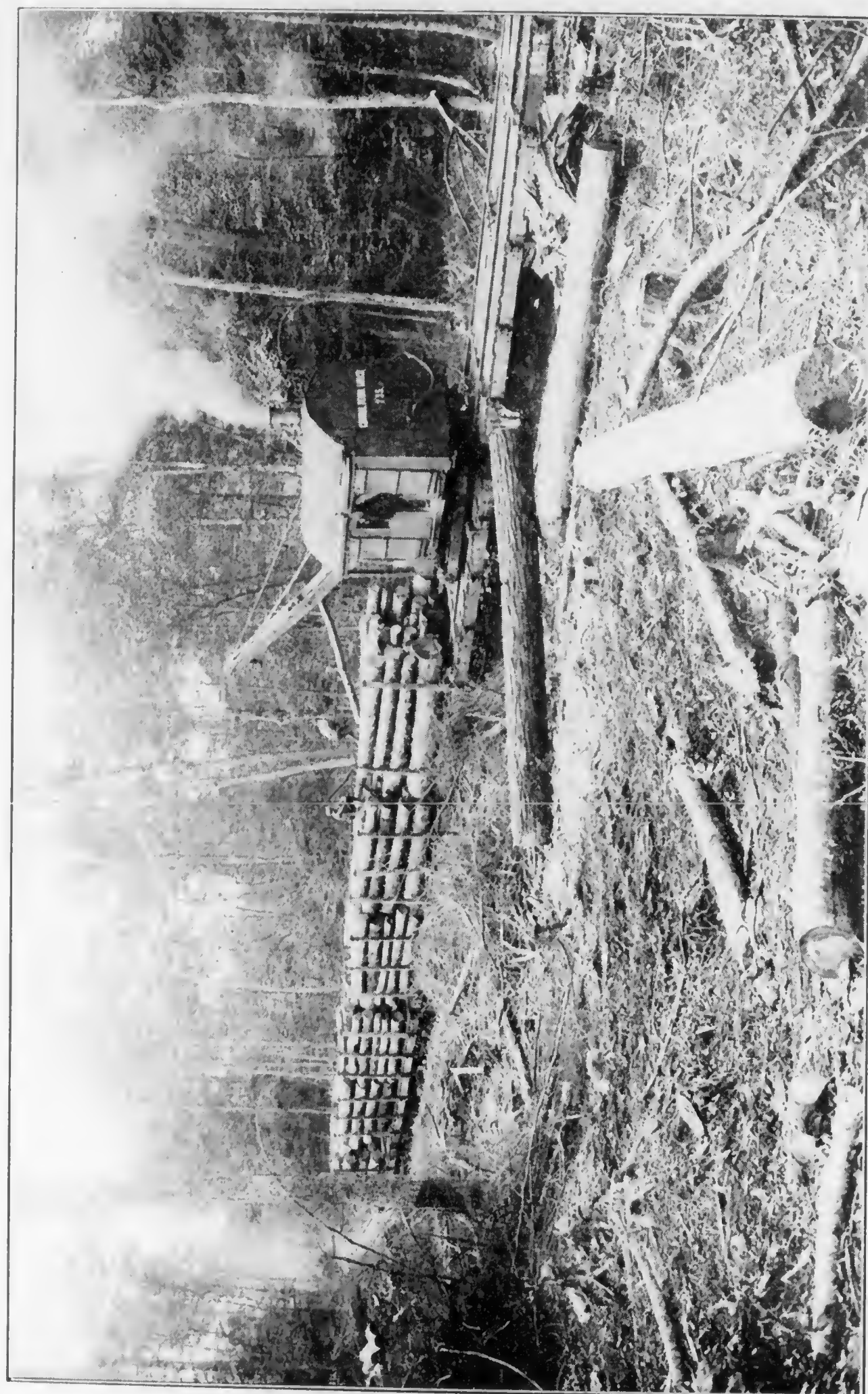
Sulphite pulp, of which hemlock supplies great quantities, is made by cooking chipped pieces of wood in a solution of calcium sulphite, which loosens and frees the wood fibres that are the basis of the finished paper. The reason that hemlock is considered inferior to spruce for pulp is because the fibres in the wood of the latter are longer than they are in hemlock wood.

About twenty years ago an attempt was made to utilize for pulp the waste pieces of hemlock left lying in the forests of Pennsylvania following lumbering and bark peeling operations. Wood from tops, from broken trees, and from defective logs was gathered and sold by the cord for manufacturing pulp. In as much as small bolts can be used for making pulp, it is possible to utilize considerable slab wood and other sawmill waste, which formerly was burned entirely to get rid of it.

THE PICTURESQUE HEMLOCK

To enjoy the full beauty of the hemlock one must observe it growing in the open or at the edge of the forest. More graceful than the pines and less stiff and formal than the spruces and firs, the foliage of the hemlock has a dark green glitter and from its feathery tip down to near the ground is so dense that it hides the stem from sight. The multitude of slender branches lie one above the other, their tips resting on those below like the feathers on a bird's wing. These slender sprays with their ranks of delicate needles undulate gracefully when swayed by the wind.

Few trees in Penn's Woods produce new spring growth with the beautiful appearance that characterizes the greening of the hemlock. Each new branchlet is tipped with a delicate pale green that forms a delightful con-



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Even when growing in the deep forest the hemlock takes a form which, if less graceful than that of the open grown type, is none the less attractive in its wild ruggedness. Here it is a tapering shaft, from fifty to one hundred feet high, near the summit of which is a crown of foliage that usually tops the level of the surrounding trees. The shaggy appearance of the tree is heightened by the dead branches that project from the trunk on all sides.

Dense forests of mature hemlocks are cool and moist and gloomy. John Greenleaf Whittier observed them thus and wrote:

*Where the hemlocks grew so dark
That I stopped to look and hark.*

Another of his descriptions recalls the sunlight penetrating the depths of the forest:

*How yonder Ethiopian hemlock,
Crowned with his glistening circlet, stands,
What jewels light his swarthy hands.*



THE BEGINNING OF LONGFELLOW TRAIL AT THE TOURISTS' CAMP IN COOK FOREST PARK

Where Whittier saw something lowering and cheerless about the forest hemlocks Longfellow found a happier and more hopeful significance, and expressed his thoughts in verses that have since been set to charming music:

*O Hemlock tree! O Hemlock tree!
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But in the winter's frost and rime,
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A. J. Downing, known as the father of landscape gardening in America, pronounced the hemlock the most picturesque and beautiful of all the evergreens in the world. When making this statement he probably had in mind its ornamental use, for which purpose it is an exceptionally useful and attractive plant. So highly was the hemlock esteemed for its beauty that it was introduced into England as early as 1736.

The hemlock, as well as its several varieties, the most distinct forms of which are those known as *pendula* and *compacta*, has been planted extensively as an ornamental evergreen for many years, both in the United States and abroad. The *pendula* variety has graceful, drooping branches, sometimes called weeping hemlock. The variety *compacta* has a dense, broadly pyramidal form. George B. Sudworth, dendrologist of the U. S. Forest Service, listed 16 varieties of the hemlock in cultivation.



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Both these plants have been extensively propagated by grafting, and these and various other varieties may now be purchased from growers of ornamental nursery stock. The two Japanese species also have been propagated from cuttings and are sometimes grafted on to our native hemlock.

In addition to its value as an ornamental tree the hemlock has been used rather widely as a hedge shrub. It makes an attractive hedge, which is particularly showy when the delicate new shoots of spring appear. Careless trimming and neglect will spoil a hemlock hedge. Some landscape gardeners recommend it especially for small enclosures near houses to protect delicate plants and shrubbery.

CHRISTMAS TREES

During recent years the hemlock has gained great popularity as a Christmas tree. As far as beauty of form and foliage are concerned this popularity is well merited for when gaily decorated with tinsel, bright ornaments, and colored lights the hemlock is as handsome a Christmas tree as can be found.

There is one feature of the hemlock that it is well to keep in mind, however, when selecting it for a Christmas tree and that is, the tree must be freshly cut or the needles will drop off the branches soon after it is placed in a heated room.

If one wishes to bring a hemlock into the home at Christmas time and decorate it, there is a better way than by buying a cut tree, a way that will insure that the needles will remain fresh, keep their delightful woody fragrance, and not fall off in a day or two. Most up-to-date commercial nurseries sell hemlock transplants and ornamental stock. One may select a fine bushy hemlock and have it planted in a pot or tub, which may be used as a part of the landscaped yard or lawn throughout the year. When the holidays arrive the tree in its container may be brought into the home and decorated. If kept well watered and if not allowed to remain too long in the warm house, the plant can be set out of doors after it has served as a Christmas tree. By this method one is sure of having a fresh Christmas tree each year, and the original investment may well be the last one.

Since the custom of stringing colored lights on trees that stand on the lawn before the home has become so wide-spread, one may use hemlocks for this purpose simply by planting them where an electric outlet is accessible. If the prospective planter is not certain of his ability to plant a large hemlock so that it will grow and thrive, there are nurserymen and landscape architects who make a specialty of this type of planting and who will guarantee that any tree they may plant that does not succeed will be replaced free of further charge.

IS THE HEMLOCK POISONOUS?

Students acquiring classical knowledge often mistakenly get the impression that the hemlock is poisonous because they are taught that a certain fatal drug of that name was occasionally meted out to those citizens of ancient Athens who were so unfortunate as to embarrass the governing political party of that fair Grecian city. They recall that the bold philosophical and social ideas of Socrates, who spoke too often and too well, were eventually quenched by a draught brewed from the hemlock. But what



AMONG THE HEMLOCKS ALONG BEAUTIFUL MOHAWK TRAIL IN
COOK FOREST PARK



SUNLIGHT FILTERING THROUGH THE FOLIAGE OF PINES
AND HEMLOCKS

Socrates drank was the infusion of an herb belonging to the *Conium* genus, a plant related to our wild carrot that grows in Europe and contains poison in root, stem, leaf, and seed.

As a matter of fact our hemlock tree is not poisonous at all. Even to believe that the hemlock tree is noxious, in the sense that poison ivy and poison sumac are harmful, is nonsense.

Indeed, the hemlock has been highly valued for its medicinal properties, especially by the American Indians and the early settlers. Oil of hemlock, distilled from the leaves, was used medicinally for many years. The drug known as Canada pitch was extracted from the leaves and knots and made into plasters for external application to the body.

The Indians boiled the bark of young hemlocks, pounded it to a paste, and made poultices that had antiseptic properties, for sores and wounds. A kind of turpentine made from the hemlock pitch or resin was noted for its healing qualities when rubbed on aching joints and muscles. A powerful astringent in fluid form is extracted from the hemlock bark.

REFORESTATION WITH HEMLOCK

It used to be said of hemlocks that "They are like Indians, they will not stand civilization," but this old saying no longer applies. In recent years hemlocks have been grown quite successfully in nurseries for ornamental planting, and foresters are now learning how to raise and transplant them for reforestation purposes. A number of forest plantations of hemlocks have been established in Pennsylvania throughout those regions where the climate and soil are suited to its growth, though there is still much to be learned about planting hemlock for timber production, and its use is still in the experimental stage.

They grow readily from seed if the seedlings are kept shaded. Whereas many species of trees demand considerable sunlight for their growth in early life, the hemlocks are shade demanding and too much sunlight will kill them. More than 100,000 transplants, raised in the four State Forest nurseries operated by the Pennsylvania Department of Forests and Waters, have been planted in the State Forests. Nursery inventories indicate that there will be an additional 100,000 transplants available for State Forest planting in 1934, and that of the quarter-million seedlings, which will be three years old in the fall of 1934, practically all will be set out for the production of transplants for timber.

Because of their dense fibrous root systems hemlocks may be successfully transplanted if precautions are taken to guard against the roots drying out. For ornamental planting it is now customary to prune the young trees, both tops and roots, which makes hardier plants.

Young hemlock seedlings that come up naturally in the forest are extremely slow growers. For the first five years they may not average more than one inch each year, though during this period they develop good root systems, and later grow more rapidly. In the nursery they can be made to grow as vigorously in two years as they might grow in five or even more under Nature's methods in the woods.

At the Clearfield State Forest nursery in Clearfield County the nurseryman can show you four-year-old transplants that measure twelve inches from root collar to tip. These transplants have adequate root systems and are entirely satisfactory for use in reforestation projects, but only where the soil and other factors of the planting site are favorable for the growth of this species. Even though hemlock once grew on a certain site does not indicate that it will grow there again, especially if fire, sunlight, and changes in vegetation have altered conditions.

Foresters do not recommend planting hemlock in open fields unless the soil is very moist or the site is a steep northern exposure, or preferably both. Nature imposes rigid conditions under which hemlock shall grow in the wild woods. The shelter of other trees is one of the principal necessities. If hemlock transplants are planted under other trees, on northern slopes, and where other conditions are favorable, they should grow successfully.

Since the young hemlocks commonly thrive in shade dense enough to kill other kinds of trees, they are particularly well suited for under planting on sites where aspen, fire cherry, sassafras, and other so-called weed species are now growing, and where, previous to lumbering operations and forest fires, hemlock was abundant.



RUSTIC STEPS LEAD UPWARD FROM THE HEMLOCK-CLAD GORGE IN
CHILDS STATE FOREST PARK

THE ENEMIES OF HEMLOCK

Fire

Although fire may be said to be the most destructive foe of trees and forests generally, it is particularly so to the hemlock. The intense heat kills the small tender seedlings and saplings when the fire burns over the surface of the ground through the inflammable leaves and humus on the forest floor. Even though a fire burns lightly it may do considerable damage to the shallow-rooted hemlocks while trees with deeper root systems may escape injury.

Since hemlock roots are usually close to the surface of the ground the heat need not be great enough actually to burn the roots, but, if it dries out the humus, conditions of moisture may be sufficiently disturbed to cause the gradual death of the trees. Fires often burn at the butts of the hemlocks, and without killing the trees, badly scar them so that they are laid open to later attacks by insects and fungi.

Crown fires, those that blaze through the forest in the tops of the trees, are always fatal. During prolonged dry seasons, such as occurred in 1930 and 1931, crown fires may develop from surface fires when the wind is high, and when they burn through the oily, resinous coniferous leaves and branches all that remains are bare, charred skeletons of trees.

One of the most valuable contributions any one can make toward con-

serving the trees and forests of our State is to help to prevent and control fires in the woods.

Wind

The wind may cause damage to hemlock trees in two ways. Because the hemlock is shallow-rooted it is susceptible to windfall. Entire stands of hemlock trees have been thrown over by high winds. There is a record of a storm that occurred in 1896 in Luzerne County, Pennsylvania, that blew down six million feet of hemlock in one tract. In the case of an open-grown tree whose roots are deeper and more secure than those of trees standing in the woods, the wind may lack power to up-root it but may snap off the top or break the trunk.

The more common and more serious injury done to hemlock by wind, though its effects are less evident, is known as wind-shake, caused by the layers of wood separating as a result of the wind swaying and rocking the tree. Wind-shake makes the butts unfit for lumber, hence there is considerable waste in high stumps and discarded butts when the trees are harvested.

Drought

The prolonged droughts of 1930-31 caused the death of many hemlock trees throughout Pennsylvania. The severity of the drought damage appeared to be greatest to trees growing on sites with southern exposures.

The injury was not immediately apparent, because the needles became brown and fell very slowly. Hence, several months passed before their death was noticed, though there is every reason to believe that the principal cause was the dry weather.

Large and small trees alike were affected. The mortality among small hemlocks was particularly high where they had come up from seed along roadsides, on earth fills, on raw mineral soil, and on rocky slopes where the roots did not penetrate deeply into the soil.

Winter Injury

Notwithstanding the fact that the wood of the hemlock is brittle, trees are not seriously damaged by heavy snow and ice storms. Extending nearly horizontally from the trunk, the branches bend easily and snow and ice accumulations usually slide off before they break.

Spring frosts seldom injure the needles of hemlock because their new growth appears late in the season. Although the tree is resistant to early fall frosts, hemlocks should never be planted in frost pockets, which are localities where heavy frosts are frequent and severe, because they are almost certain to have their new growth frozen back each year. Frost heaving of young seedlings and transplants from the soil is apt to occur in exposed localities.

Insects

An insect known as the spotted hemlock borer, one of the flat-headed borers, causes the loss of many hemlock trees. If this pest does not kill the trees outright, it may hasten their death from other causes. The eggs of the borer are laid in the spring in the crevices of the bark, and hatch into small kite-shaped larvae, which enter the bark and make irregular tunnels beneath the surface and through the inner bark layers. The larvae do all their boring within the bark and do not enter the sapwood.

The larvae of a long-horned borer, an insect that often works jointly with the spotted hemlock borer, mines in the sapwood of dead and dying



A NORTHERN PENNSYLVANIA LAKE AS SEEN THROUGH
A VISTA OF FILMY HEMLOCK BRANCHES

trees and frequently makes the wood unfit for commercial use. Removal of the bark and infested portions of the wood will prevent the further spread of this insect.

Disease

No serious parasitic diseases attack the living hemlock trees, either in the seedling stage or during maturity. Damping-off, a great scourge of newly germinated seedlings, rarely does any damage to the seedlings of this species. Disease epidemics, which are common among trees that grow in pure stands, seldom damage hemlocks, which usually grow in mixture with other species. Their scattered distribution in mixed forests not only tends to prevent the outbreak of epidemics, but also helps hinder the spread of diseases once they attack individual trees.

Hemlock lumber, however, is very susceptible to decay, especially when in contact with soil moisture. For this reason hemlock does not make good telephone poles, railroad ties, and fence posts unless previously treated with chemical wood preservatives which resist the attack of wood-rotting fungi

LEARN TO KNOW THE TREES

Trees are among the most beautiful and useful of animate objects in Nature. Anyone, who takes the time to learn their habits so that he can call them by name, gains a host of lifelong friends.

The beauty of trees finds expression throughout the seasons,—their delicate blooms of spring, the rich maturity of their summer green, autumnal foliage with its carnival of colors, and their stark rugged strength in winter.

The association of trees and mankind has been intimate from the earliest times. In this modern, busy machine-age, we as a highly civilized people are no less dependent upon trees than were our pioneer ancestors who used the products of the forest for food, shelter, and sustenance.

Pennsylvania's progress, economically and socially, is inseparably associated with her trees and forests. They have continuously contributed to the well-being of our people, not alone by reason of their utilitarian value, but by their appeal to the aesthetic as well.

Pennsylvania's trees are Pennsylvania's treasures.

INTERESTING FACTS ABOUT PENN'S WOODS

Those who have been sufficiently interested to read about the State Tree of Pennsylvania may wish to know something further about forests and forestry in the Commonwealth. It should be a matter of pride to every Pennsylvanian to know that his State was one of the earliest to promote forestry practice by providing for a State-wide forest fire control organization, by acquiring State Forests, and by carrying on reforestation projects.

The present Department of Forests and Waters, which has a personnel of 52 technically trained foresters and 78 forest rangers, in addition to other employes, grew out of the old Division of Forestry created in 1895 in the Department of Agriculture, at which time there was not one native born technical forester in Pennsylvania, or for that matter, in the entire United States. So, you see, State forestry in Pennsylvania is now just about 40 years old.

The State's Woodlands

Since primeval times Pennsylvania has been a densely wooded State. Even today 45 per cent of the total area is woodland, or about 13,000,000 acres. Less than 20,000 acres of virgin timber remain.

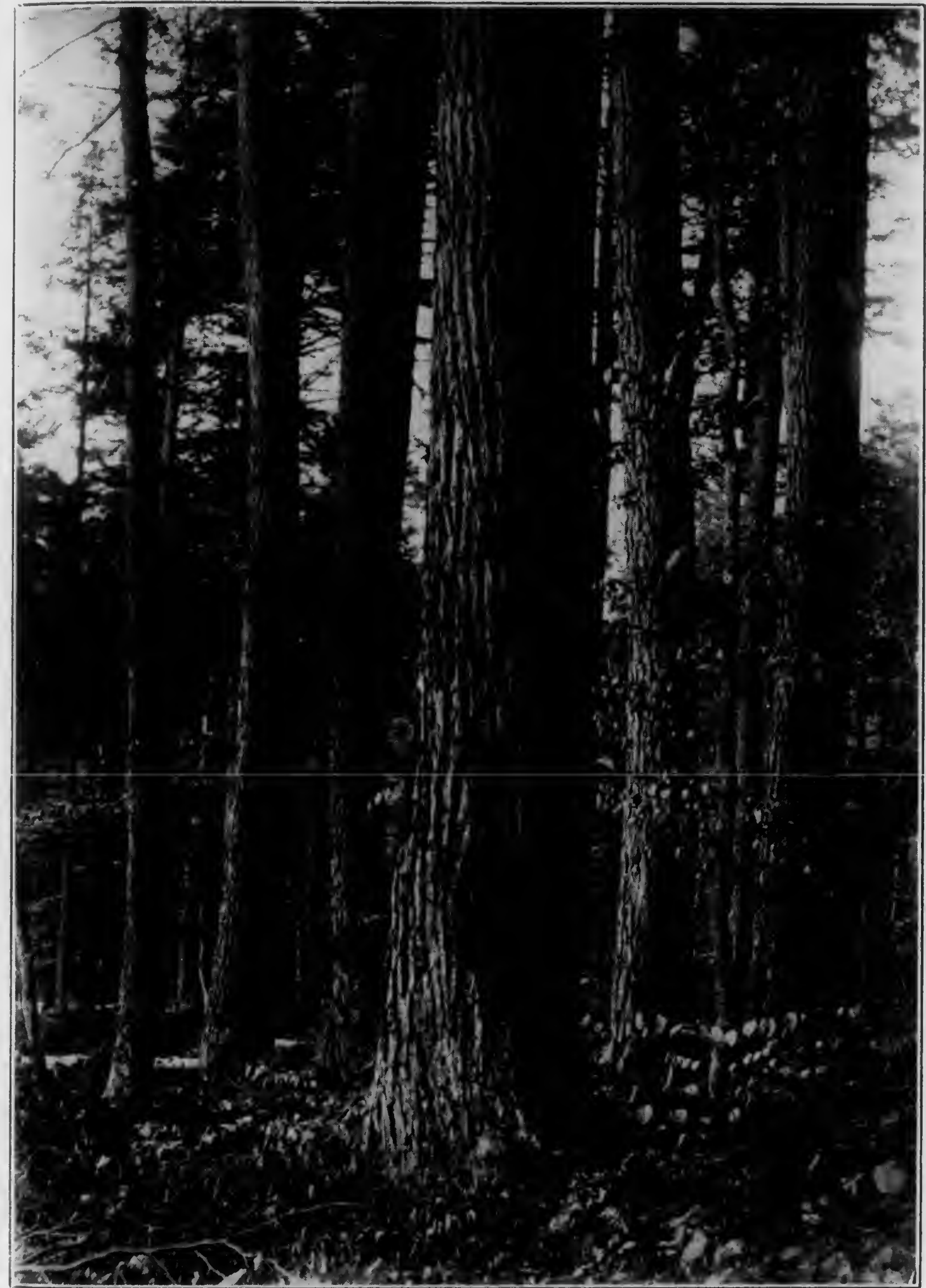
Under the provincial government of Pennsylvania, of which William Penn was proprietor and later governor, various rules and regulations were enacted to encourage forest cultivation for the benefit of shipping and industry. The woods were so extensive, however, that for a hundred years longer they were cut and burned without people realizing that the supply of virgin timber might eventually be exhausted.

At the time of the Civil War and until 1875 Pennsylvania led all the other states in lumber production, and for several decades lumbering was the principal industry in the Commonwealth. By the end of the 1890's forest devastation, at first as the result of lumbering, later, by forest fire, had made such inroads into the remaining timber stands that a group of public spirited individuals, led by the late Dr. Joseph T. Rothrock, urged that laws be enacted, restraining further forest denudation and creating State Forests.

The State Forests

The first authorization for the purchase of woodland for State Forest purposes was made by the General Assembly in 1897, and during the following year 17,010 acres were acquired. Now, after thirty-seven years of land acquisition, the State Forests comprise 1,647,850 acres, located in 35 counties. They are located chiefly in the mountainous regions where the soil is primarily adapted to growing successive crops of timber. Although the maximum price that may be paid for State Forest land under the law is \$10 per acre, the cost per acre has averaged \$2.43 only.

<i>County</i>	<i>Area (Acres)</i>
Adams	20,934
Bedford	16,928
Cameron	118,987
Carbon	606
Cambria	70
Centre	122,841
Clarion	1
Clearfield	84,255
Clinton	231,502
Cumberland	34,667
Dauphin	3,808
Elk	61,053
Fayette	58
Forest	2
Franklin	37,969
Fulton	30,144
Huntingdon	64,555
Jefferson	9,013
Juniata	8,977
Lackawanna	5,274
Lycoming	149,735
Luzerne	11
McKean	2,441
Mifflin	53,029
Monroe	6,567
Perry	32,525
Pike	59,417
Potter	250,360
Snyder	27,418
Somerset	14,657
Sullivan	38,885
Tioga	99,400
Union	55,423
Westmoreland	5,161
Wyoming	1,177
Total	1,647,850



A STAND OF VIRGIN HEMLOCKS IN MCKEAN COUNTY AS THEY LOOKED
BEFORE THE LUMBERMAN CUT THEM



VIRGIN HEMLOCK AND OTHER TIMBER TREES
ALONG LONGFELLOW TRAIL IN COOK FOREST
PARK

To protect the State Forests as well as all other woodland from their greatest scourge—forest fire—there are, in addition to the foresters and rangers, 4,000 commissioned forest fire wardens. Forest fire observation stations, to the number of 126, are maintained by the Department of Forests and Waters for detecting and locating forest fires. The lookout towers, which vary in height from 50 to 80 feet, are of steel construction and are located on the highest knobs and ridges of Pennsylvania's mountains.

Four State Forest nurseries with an annual production of ten million trees are operated by the Department of Forests and Waters. The seedlings and transplants grown in these nurseries are sold for timber production and watershed protection. To date about 110,000,000 trees from the State nurseries have been used to reforest privately owned land in Pennsylvania, and about 43,000,000 trees have been planted in the State Forests.

Two million campers, hunters, fishermen, and others seeking rest and recreation in the out-of-doors use these woodland areas annually. Nine State Forest parks, 11 State Forest monuments, and 50 public camps have been developed by the Department of Forests and Waters for outdoor

recreation. Within these popular retreats are facilities for tourist comfort. Fireplaces for cooking, pure water, tables, benches, and shelters are provided.

Some of the best hunting grounds and fishing waters are found within the State Forests, and at least 200,000 hunters and 100,000 fishermen use them annually. Nearly one-half of the number of deer and more than one-third of the number of bear, in addition to large quantities of small game, killed by hunters each year are shot within their boundaries. They contain 20 State game refuges and 13 auxiliary game refuges, the combined area of which is approximately 50,000 acres. Game birds and animals breed in these sanctuaries unmolested by humans and protected from predatory animals, and they provide an increasing abundance of wild life to replenish the surrounding forests.

Although considerably more could be written about the State Forests, perhaps I have told you sufficiently to arouse your curiosity about these vast woodland areas so that you will be impelled to learn more about them and to visit them when opportunity offers. Remember that the State Forests are the people's forests, and as such are wide open for public use. All that is asked of the visitor is that he obey the law and be careful with fire in the woods.



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RECREATION

*In the State Parks
and State Forests
of Pennsylvania*

By

William E. Montgomery

Bulletin no. 53

Commonwealth of Pennsylvania
Department of Forests and Waters

Ralph M. Bashore, *Secretary*

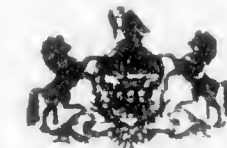
PFW 113

RECREATION

In the State Parks and State Forests of Pennsylvania

By

William E. Montgomery, *Director*
Bureau of Forest Management, Lands and Parks



[Bulletin 53]

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS

Ralph M. Bashore, *Secretary*

Harrisburg
1935

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NATURE'S WONDERLAND · A LAGOON ON HISTORIC PRESQUE ISLE IN THE POPULAR STATE PARK AT ERIE

INTRODUCTION

Regardless of the results of the present and proposed experiments in industrial procedure, economists of all shades of opinion seem to be in accord in prophesying that the work-day of the future, the near future, will be decidedly shorter than that of the past and that the working week will be comprised of fewer days. Aside from their effects upon business, labor, and trade, these changes are significant by reason of the fact that they will increase tremendously the amount of leisure time at people's disposal.

Hence, of overwhelming importance is the question: How and where will these leisure hours be spent? It will, of course, sound like an exaggeration to say that upon the answer to that question will depend to a very considerable extent the future of the State and the Nation. And yet, in the final analysis, doesn't that very nearly describe the situation? For unquestionably the utilization of this additional leisure time, which will eventually be available to great numbers of American citizens, cannot help but have its effect upon the habits of thousands, yes millions, of people. And by these habits, in turn, inevitably will the thoughts and the opinions of the people, their very outlook upon life itself, be influenced and transformed.

Everyone is aware of the efforts which various agencies are exerting in guiding boys and girls in the proper and beneficial use of their leisure hours, and no one can fail to recognize the value of those agencies in preparing the youth of the nation for citizenship. In the near future, however, increased spare moments for adults are bound to complicate and intensify the problem. What will be the result?

Many persons competent to form an opinion firmly believe that for one thing, if properly directed, the new leisure will lead to a renaissance, to a rebirth of interest in things of cultural and spiritual qualities—art, literature, music, science, history. There will be a re-newed pilgrimage to, and an awakened interest in, those galleries wherein one may receive inspiration from the works of the painters and sculptors of all times. There will be greater crowds enjoying the wonderful harmonies of orchestras and of individual artists as they interpret the works of the masters of musical composition.

The demands upon library facilities, in many localities already doubled or trebled in the depression, will increase steadily as men and women of all classes seek again the beautiful sentiments and superbly phrased passages of the classics. The museums will teem with the multitudes as they study the history of the past as portrayed in the great variety of exhibits, as they observe scientific facts so skilfully and expertly indicated by model and example, as they marvel at the grotesque and curious specimens assembled for their information.

In the second place, the existing trend to the great outdoors will be accentuated. Every year this has been of more and more importance as the number of automobiles increases and as people continue to turn, in even larger numbers, to the great outdoors where they may gaze upon and enjoy the beauties of nature. And it is but logical that it should be thus.

Scientists claim that human life has existed on Earth for at least 150,000 years, probably double or even treble that period. In consider-



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ing that great length of time, is it not indeed just recently, comparatively speaking, that humans have been living anywhere else than in or near the forests? And so during times of leisure, it is but second nature, a sort of inherent instinct, that so often prompts people to turn to the great outdoors—particularly to the wooded portions of it. And it is well that they should, for Nature offers much of knowledge and inspiration not to be obtained from man-made things.

The essayist speaks truly in saying that for many ailments there are "few medicines so potent as the sweet breath and sweeter seclusion of the woods, few tonics like a free life under the open skies where Health awaits like an invisible goddess eager to share with all who come to her shrine."

And here it is that the Department of Forests and Waters, and its various affiliated boards and commissions, enter into the picture. For not only can those who long merely for outdoor pleasure be satisfied in the State Forests and State Parks, but to a great degree will the higher and better things of life be inculcated in those who take advantage of the opportunities which the Commonwealth thus presents.

It may not be feasible to study history from books while on a tour of the State Parks and State Forests, but it certainly is possible to see the places where history has been made and thus be inspired by the acts and deeds of the founders of the Republic and those who have succeeded them in leadership. The forests perhaps cannot provide an interpretation of the work of Chopin, Bach, Liszt, or Beethoven at the talented hands of a Paderewski, a Rachmaninoff, or a Kreisler, yet there is music in the woods. To the untrained ear, the forest seems to be filled with a confused murmur, a combination of unrelated sounds, yet to the sympathetic auditor these become a succession of beautiful notes, clear and distinct, component parts of a divine harmony of unexcelled sweetness. And how soothing it is to sit beside a rippling brook in the heart of the forest and listen to its tune, or to hearken while the wind rustles musically through the leaves overhead and the nearby waterfall sings its song of carefree joy. Although in the State Parks and State Forests there are no art galleries in which may be seen the chiseled stone of a Phidias or a Michelangelo, the painted canvas of a Turner, a Gainsborough, or a Corot, yet even these wondrous and almost priceless works of art are surpassed by the glories of nature as revealed in Pennsylvania's hills and mountains. No matter how skilful and talented men may be, they have always failed, even in their greatest efforts, to equal the marvelous views, landscapes and natural formations depicted by the Great Artist of the Universe. And in the Keystone State will be found many of His finest treasures. At various points of vantage throughout the wooded portions of the State, 144 steel towers have been erected to facilitate the prompt detection and correct location of forest fires. From them can be obtained panoramas of a large part of the mountains of the State. It would be difficult to single out any particular tower as offering the choicest view, since on a clear day a visit to any one of them will prove well worthwhile.

In the following pages, reference will be made to State Parks, State Forest Parks, State Forest Monuments, and State Forest Public Camps, and to the work of the Department of Forests and Waters in connection with these areas. To present a clear picture of the recreational set-up in Pennsylvania, as far as the Commonwealth itself is concerned, it is ap-

propriate to state that by law the Department of Forests and Waters is charged with the duty of promoting healthful outdoor recreation and education.

As a general statement it may be said that the recreational activities of the Department of Forests and Waters may at the present time be grouped under three principal heads:

(1) State Parks administered by semi-independent commissions affiliated with the Department of Forests and Waters;

(2) State Parks operated directly by the Department of Forests and Waters, in some cases assisted by advisory commissions;

(3) State Forest Parks, State Forest Monuments, State Forest Public Camps, and the State Forests themselves managed and administered solely by the Department of Forests and Waters.

In the first group are the areas under the jurisdiction of the Valley Forge Park Commission, the Washington Crossing Park Commission, and the State Park and Harbor Commission of Erie. In the second group are Bushy Run Battlefield and Fort Washington State Parks, each with an advisory commission; also Roosevelt and Fort Necessity State Parks, Cook Forest Park, and the Ralph Stover Tract. For these, the State Parks Commission acts in an advisory capacity.

With the exception of the Ralph Stover Tract which was donated under a recent general act permitting the Department of Forests and Waters to accept land for recreational use, all the State Parks have been created by specific acts of the Legislature.

THE STATE PARKS

BUSHY RUN BATTLEFIELD STATE PARK

Westmoreland County

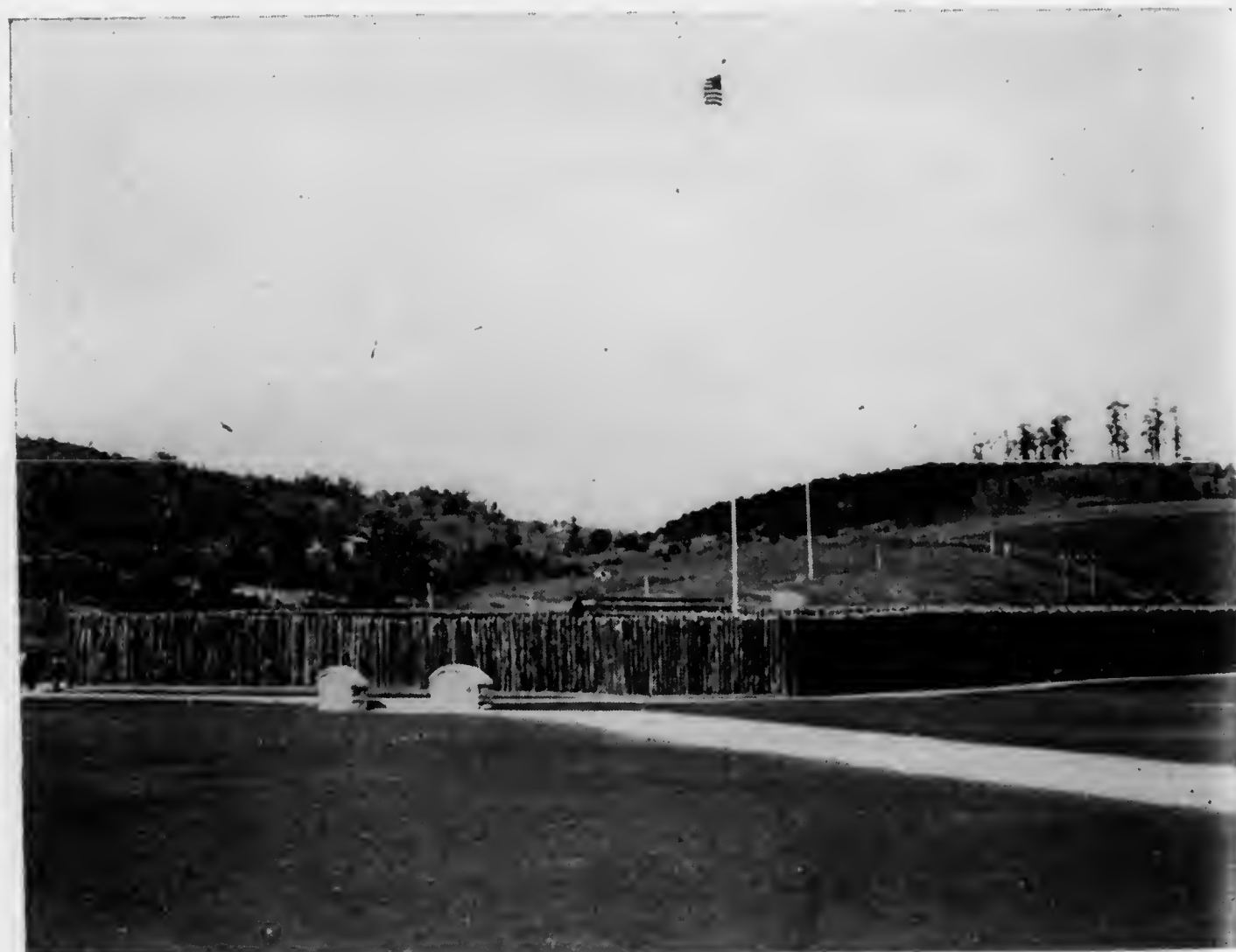
Not far from Jeannette is Bushy Run Battlefield, the scene of a decisive battle in August, 1763. Colonel Henry Bouquet with a small force of Highlanders and Colonials was taking supplies and men to the relief of Fort Pitt then besieged by Indians. He was ambushed by Guyasuta and an overwhelming force of Redskins, and turned apparent defeat into victory by a clever strategy, pretending to retreat in disorder and then surprising the enemy by a sudden flank attack. The outstanding point of interest in this park is the hill at the top of which was the famous Flour Bag Fort.

Several hundred yards away is Byerly spring to which, according to tradition, Andrew Byerly and other woodsmen made repeated trips through the Indian lines in order to secure water for the relief of the wounded. In the large spring-house erected here are many relics of bygone days. This collection has been increasing rapidly and plans are now being prepared for the erection of a suitable museum. The entire area owned by the Commonwealth, aggregating 169 acres, has been developed for recreational use by the construction of roads, trails, shelters, playgrounds, toilet facilities, pumps, tables, benches, parking spaces, and fire places. A "ceremonial lodge" patterned after those used by the Indians has recently been completed, and the erection of several other structures of similar design is planned.

FORT NECESSITY PARK

Fayette County

Fort Necessity State Park, near Uniontown, is the site of George Washington's first battle—a battle which has been authoritatively cited as one of the most significant ever fought, considering the chain of events which led from it—resulting in an almost complete change of all the national boundary lines in Europe and America. The site of the fort itself, which is owned by the Federal Government, is several acres in extent and is entirely surrounded by about 350 acres of State-owned land. A log fortification, built upon the exact location of the original stockade, has been constructed. A fine old brick building along the National Highway is used as a museum, and in it has been placed an extremely valuable collection of relics of all kinds. Although Fort Necessity Park as a whole has only been partially developed because of lack of funds, yet the fort and the museum are well worth repeated visits.



REPLICA OF THE ORIGINAL STOCKADE AT FORT NECESSITY PARK, THE SITE OF GEORGE WASHINGTON'S FIRST BATTLE

Plans have been completed and it is hoped that in the very near future this park may receive the attention which it so thoroughly merits by reason of its historical importance. If the number of persons who visit this park in its present undeveloped condition may be accepted as a criterion, there will be few spots in the State surpassing Fort Necessity in popularity when ample provisions are made for the proper accommodation of the public.

VALLEY FORGE PARK

Chester and Montgomery Counties

In the southeastern section of Pennsylvania between Norristown and Phoenixville is Valley Forge Park, comprising approximately 1600 acres of land, situated along the southern bank of the Schuylkill River and embracing the ground hallowed and consecrated by the privations and sufferings of the Continental soldiers during the terrible winter of 1777-1778. Here it was that General Washington's strength of character and his almost super-human capacity for leadership were best displayed.

There are a number of extremely interesting features at Valley Forge Park, among the most important being the remains of both the inner line and outer line of entrenchments and the hut holes over and above which crude buildings were erected to shelter the half-starved and half-frozen patriot soldiers from the chilling, wintry blasts. The Potts' home which served as the headquarters of General Washington during most of the period of the encampment is still standing. This building has



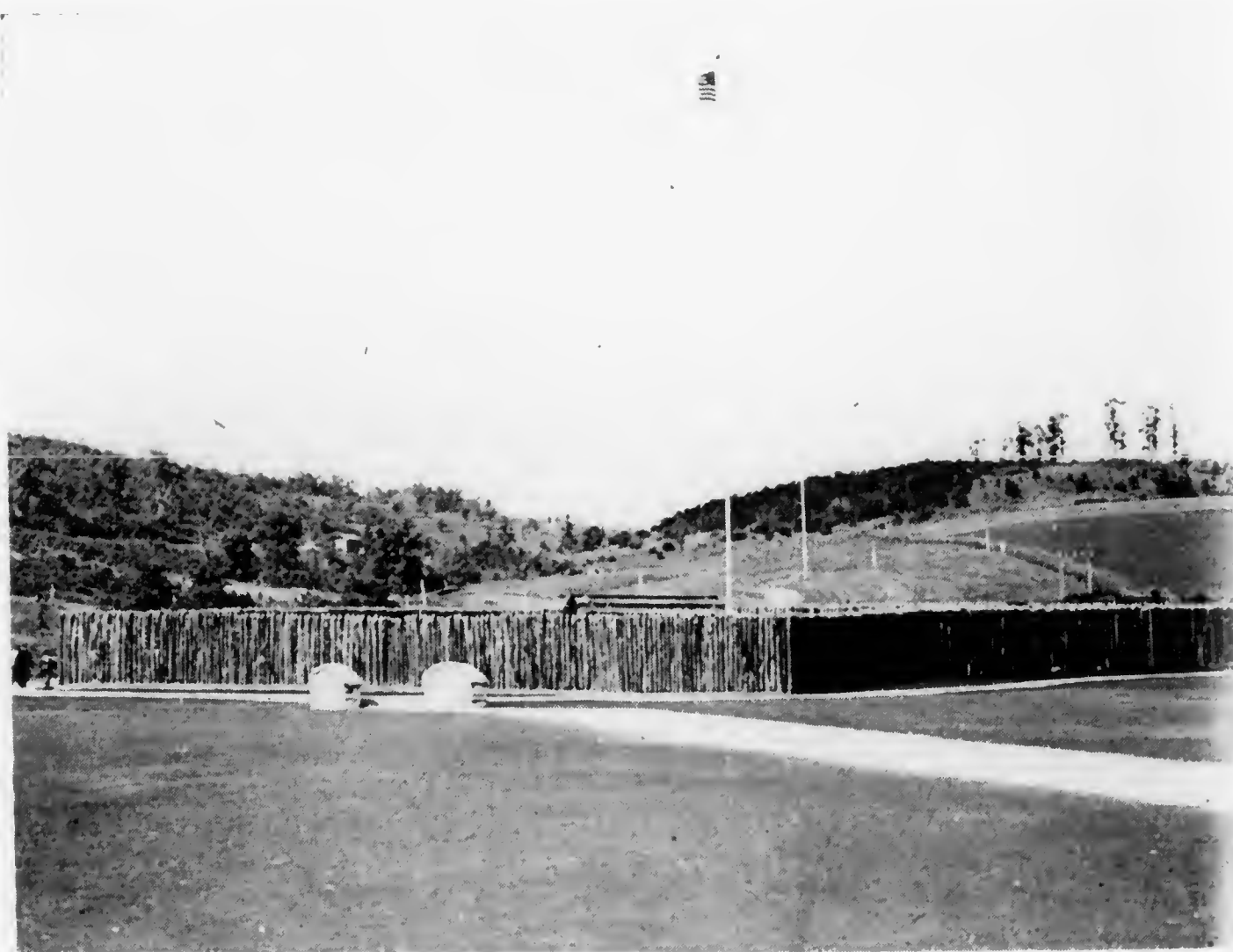
GENERAL WASHINGTON'S HEADQUARTERS AT VALLEY FORGE

been completely refurnished with articles that are unquestionably of the type appropriate to the place and period. During the years that have passed the old building has undergone a number of changes, particularly in connection with the so-called kitchen wing. As a result of a long study by the Committee on the Restoration of Historic Landmarks of the American Institute of Architects, aided by numerous historians of

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There are a number of extremely interesting features at Valley Forge Park, among the most important being the remains of both the inner line and outer line of entrenchments and the hut holes over and above which crude buildings were erected to shelter the half-starved and half-frozen patriot soldiers from the chilling, wintry blasts. The Potts' home which served as the headquarters of General Washington during most of the period of the encampment is still standing. This building has



GENERAL WASHINGTON'S HEADQUARTERS AT VALLEY FORGE

been completely refurnished with articles that are unquestionably of the type appropriate to the place and period. During the years that have passed the old building has undergone a number of changes, particularly in connection with the so-called kitchen wing. As a result of a long study by the Committee on the Restoration of Historic Landmarks of the American Institute of Architects, aided by numerous historians of

note, work has recently been completed upon the kitchen wing which restored it to the condition that undoubtedly existed at the time the building was used by Washington as his headquarters.

The excavated ruins of the old original forges from one of which the place took its name may be seen. Partly as a result of a map made by General DuPorteil, a French engineer upon Washington's staff, it has been possible to excavate, from beneath the silt deposited during the intervening years, the wheel pit and a corner of the foundations of the original Valley Forge. Further work was impracticable because the remainder of the building extends under the existing State Highway. By means of borings the location of the old mill race was traced back to the site of the original dam. About six years ago a dam was built at this location in an effort to restore conditions along Valley Creek to a state similar to that which existed in Colonial days. In building this dam the workers discovered the remains of the old original dam. About half a mile above it, beneath ten feet of silt, were found the remains of an auxiliary forge. The base of an upper dam, the spillway, the mill race, half of the water-wheel, the main shaft, several of the fireplaces, a trough for cooling tools, the base for the anvil block, and other articles of interest were recovered. It is the hope of the Commission that it will be possible to erect a permanent building around the remains of this old forge.

General Varnum's headquarters which is now in course of restoration, the great parade-ground where Von Steuben drilled the Continentals and transformed them into an effective fighting force, the National Arch erected 20 years ago by the Federal Government at a cost of nearly \$100,000, the old Gulph Road at one time stained by the bloody footprints of the American Patriots as they trudged into camp, and the observatory on Mount Joy from which can be obtained a beautiful panorama of the park and surrounding countryside, are also points of interest.

In recent years Valley Forge has attracted thousands of people every year because of the beauty of its display of dogwood blossoms. By most visitors it is claimed that these are even more gorgeous than the famed Japanese cherries at our national Capitol. In the fall of the year the autumnal coloration in and around Valley Forge is hardly less beautiful than the display which greets the eye in the spring of the year.

Adjacent to State land, but not actually a part of Valley Forge Park, is the Washington Memorial Chapel. This structure has been aptly called the Westminster of America. Beautiful in design and construction, it endeavors to portray symbolically that spirit of sacrifice and of patriotic devotion which will always be associated with the memory of Valley Forge. Connected with the chapel but under separate management is a splendid museum in which one may spend hours of pleasure and profit. One of the most cherished exhibits is the marquee of Washington in which he lived for a while prior to moving into the Potts' House.

WASHINGTON CROSSING PARK

Bucks County

Along the Delaware River is Washington Crossing Park, commemorating the exploit of General Washington and his soldiers in crossing the river on that stormy December night in 1776 to capture the Hessians at Trenton.

Washington Crossing Park is in two sections, totalling 440 acres. The southern portion is located in and around the point of embarkation and the valley of concentration where the troops assembled prior to entering the boats which were concealed between the mainland and Taylor's Island. The landscape of this lower section of the park is formal in design in contrast to the naturalistic treatment accorded to the upper section or what is termed the Bowman's Hill region.

On this latter tract, which is four miles north of the point of embarkation, Washington's army was encamped prior to the crossing. On Bowman's Hill was a signal station from which sentries watched the New Jersey side. Here a stone observation tower 110 feet high has been erected.



AN HISTORIC SHRINE: THE POINT OF EMBARKATION AT WASHINGTON CROSSING PARK

At the base of the hill is the old Thompson-Neely house, the first portion of which was erected in 1701. In it the conference doubtlessly was held that determined the strategic movement which was so fruitful in its results and in its effect upon the American cause. This structure is an excellent example of an early American homestead.

Across the road is the old grist mill which was used for grinding grain for Washington's half-starved army. The shafts, cogwheels, and practically all of the mill machinery (except, of course, the stones themselves) are made of wood and comprise an exhibit of rather universal interest.

Through the cooperation of the Council for the Preservation of Nat-

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Through the cooperation of the Council for the Preservation of Nat-

ural Beauty, various garden clubs, civic associations and interested individuals and organizations, a Wild Flower Preserve has been started in the Bowman's Hill section. Here, it is hoped, may be found eventually specimens of all wild flowers indigenous to Pennsylvania.

STATE PARK AT ERIE

Erie County

In the northwestern part of Pennsylvania is the State Park at Erie. This park consists of a peninsula jutting out from the mainland just west of the City of Erie. At various times it has been an island instead of a peninsula, hence the name Presque Isle which is very commonly used. Including ponds and lagoons it consists of approximately 4370 acres.



BATHING IN THE WATERS OF LAKE ERIE AT PRESQUE ISLE

Originally a French possession, it was defended by Fort Presque Isle which was located upon the mainland near the harbor entrance, the first of a string of French frontier forts erected to protect the line of communication from Canada to the Ohio River and the Mississippi Valley.

At the termination of the French and Indian War the English took possession of Fort Presque Isle which had been destroyed by the French. They rebuilt it and occupied it until it was captured and destroyed by Pontiac and his Indians in the uprising of 1763.

Presque Isle was at one time claimed by no less than four States—

Virginia, New York, Massachusetts, and Connecticut. Their claims were relinquished, however, to the Federal Government, the title cleared thereby, and it was included in a sale made to the Commonwealth of Pennsylvania. Subsequent claims by the Indians were also settled, and the Indians' duplicate of the deed, given by them at the time, has been preserved and is now in the possession of the Erie County Historical Society.

Presque Isle Bay was the site in 1813 of the emergency ship yard in which Commodore Perry's fleet was built and to which he returned with the captured British fleet. The brig Niagara, to which Perry transferred his flag during the battle because of damage to the flagship Lawrence and which was later sunk in Misery Bay, was raised from its watery grave in 1913. Construction of a new Niagara, an exact replica of the original, has been started upon the southern shore of Presque Isle not far from the spot where the original vessel of that name was built. Presque Isle Bay was also the site of the launching in 1843 of the first iron-hulled war-vessel, christened the Michigan and later named the Wolverine, and now peacefully moored alongside one of the docks of Presque Isle.

In addition to its historical associations, Presque Isle has become popular as a recreational center and upon its beach on a hot summer day may be found thousands of bathers. It offers unlimited opportunities for the study of Pennsylvania flora and fauna. Fifteen miles of trails give extensive opportunity for nature study, hiking and horseback riding, while five miles of ponds and lagoons furnish excellent opportunity for canoeing and boating.

FORT WASHINGTON STATE PARK

Montgomery County

Fort Washington Park is located near the Philadelphia County line and includes Militia Hill and Fort Hill upon which the Continental Army erected fortifications at one time during the campaign in and around Philadelphia. About 360 acres of land have been purchased but practically no developmental work has been done.

ROOSEVELT STATE PARK

Bucks County

Roosevelt Park containing 315 acres, is a strip of the old Delaware Canal which was first constructed by the Commonwealth in 1831. Three years ago that portion between Raubsville and Yardley, about forty miles in length, was transferred by the Lehigh Coal and Navigation Company to the Commonwealth of Pennsylvania to be used as a State park. In addition to the use of this water for boating, canoeing, barge parties, swimming and skating, the forty miles of shaded roadway and the attractive scenery all along the old Delaware Canal, make it a beauty spot that each year attracts thousands of visitors.

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A BARGE PARTY ON THE OLD DELAWARE CANAL IN ROOSEVELT STATE PARK

COOK FOREST PARK

Clarion, Forest, and Jefferson Counties

One need not go to Europe or to the Rockies to find Nature in her best and most inspiring mood. Bordering the Clarion River is Cook Forest Park, in which is found the largest remaining stand of virgin timber in Pennsylvania. It is a really thrilling experience to wander among those giant pines and hemlocks, many of them more than a yard in diameter at breast height, and rearing their towering columns of verdure two hundred feet into the heavens. To most visitors will doubtlessly come the exhilaration that has moved the souls of so many others and with it a realization of why the great founder of the State wanted to call it Sylvania. Cook Forest Park was created in 1927 by an Act of Assembly for the purpose of perpetuating a portion of the original forests of Pennsylvania, in the interest of wholesome out-door recreation. The park, containing 6,500 acres, is beautifully located along the winding Clarion River.

Although the big trees, especially the white pines and hemlocks, are the principal attractions, the park is known throughout the State for its excellent facilities for camping, picnicking, hiking, fishing, and nature study. Although hunting is not permitted within the park area, many people visit the Cook Forest to observe wild game, including deer, squirrels, snowshoe rabbits, grouse, and other small game animals and birds.



AMONG THE BIG VIRGIN HEMLOCKS OF COOK FOREST PARK

THE RALPH STOVER TRACT

Bucks County

The Ralph Stover Tract, located along the picturesque Tohickon Creek and comprising 37 acres, was given to the Commonwealth in December 1933 by the Misses Florence and Clara Troemner and named in honor of their grandfather, a descendant of the earliest settlers. The old miller's house of Georgian design, apparently erected at least a century and a quarter ago, has been restored, springs have been walled, recreational areas located, toilet accommodations erected, and facilities for tourist and picnic parties provided. The ruins of the old mill built about the middle of the eighteenth century will be preserved in their present state. The dam, however, will be rebuilt and the old mill race once more filled with running water. This area has been used considerably for picnics and doubtlessly with the recent improvements it will increase tremendously in popularity.

This tract is particularly valuable as an accessory or auxiliary area to the Roosevelt State Park which at present includes little except the canal itself. It is hoped that additional properties may be secured not only on the Tohickon Creek, but along the other tributaries of the Delaware River in this section. By combining these with the Roosevelt Park, the latter can unquestionably serve a higher and greater recreational purpose than will otherwise be possible.



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CONRAD WEISER PARK

Berks County

Although Conrad Weiser Park is not under the jurisdiction of the Department of Forests and Waters but is supervised by the State Historical Commission, reference to the State Parks of Pennsylvania would not be complete without mentioning this beautiful and historic spot. It was originally owned and developed by the Conrad Weiser Memorial Park Association in commemoration of the services of Conrad Weiser, the great interpreter and peace-maker of Colonial times.

This park comprises 25 acres of land located along the Benjamin Franklin Highway, all splendidly landscaped, with four stone buildings and a log cabin containing many valuable antiques. There are also various monuments and markers, a beautiful lake, with the roads and paths necessary to make the area properly accessible. After the park had been fully developed by the Association, it was donated to the Commonwealth together with an endowment fund of \$20,000.00. The principal points of interest are the old homestead of Conrad Weiser and his grave surrounded by those of a number of his closest friends among the Indian chieftains. George Washington spoke truly when he said: "This departed man rendered many services to his country in a difficult period, and posterity will not forget him."

THE STATE FORESTS

The largest of Pennsylvania's recreational areas in point of size is the huge public domain comprising the State Forests. Just what, and where, and why are these State Forests? Briefly, they comprise about 1,648,000 acres of wild lands located for the most part in twenty-five counties lying in a belt which extends north and south through the central one-third of the State with McKean, Potter and Tioga Counties at the north and Adams, Franklin, Fulton, and Bedford Counties along the Maryland line. Small areas are located in the Pocono section in Pike and Monroe Counties, in the southwestern section in Westmoreland, Fayette, and Somerset Counties, and in several other scattered counties, but over 95 per cent of the State Forests are situated in that central belt.

To most persons unfamiliar with land measurement 1,648,000 acres doubtlessly may appear to be a huge area, but may not really convey any adequate idea as to its size. Reduced to miles, the acreage would cover an area as long as the Lincoln Highway as it extends from Philadelphia to the Ohio line, with a width of four miles on each side of the roadway. In terms of counties, the State Forests, if combined in one solid tract, would more than equal the combined area of the two largest counties of the State or the nine counties smallest in size.

The question will doubtlessly be raised as to the reason for the unequal distribution of the State Forests. Why do not all counties have their proportionate share or at least some State Forest land? The answer is simple. For many years during the time that the foundations were being laid for this huge public domain and large areas were being purchased, the Department was permitted to buy land only in fee simple, without reservations of any kind; and in addition the price which could be paid was, and still is, limited by law. These conditions automatically excluded most of the available lands in the anthracite fields of the north-eastern part of the State, the oil fields of the Northwest, and bituminous

coal regions of the Southwest and the higher priced areas in the Southeast.

The restrictions with regard to reservations have since been removed, but in spite of the attempts of the Department of Forests and Waters to establish purchase units in those sections where State Forests have not heretofore existed, these efforts have been for the most part unsuccessful, since for one reason or another it has always been possible to buy better land at a much lower cost in the central belt in which most of the State Forests are now located.

Since 1898 the Department has been acquiring these lands, the average price paid being \$2.47 per acre. Over \$1.00 per acre has been expended in permanent improvements and about \$6.00 in maintenance, protection, development and administration. Today these lands are probably worth at a very conservative valuation more than \$12.00 per acre—certainly a splendid investment from a purely monetary viewpoint even if the various beneficial features of the State Forests were ignored.

The purpose in view in establishing these large areas of State Forest land has been threefold: (1) protection of watersheds, (2) the perpetuation of a timber supply, and (3) for the health, recreation and enjoyment of the citizens of Pennsylvania. The first two are of paramount importance, but for the present under the subject which has been chosen reference will be made only to the third—for the health, recreation and enjoyment of the people of the State.

And this is a purpose which the State Forests are prepared to fulfill—and, as a matter of fact, have been fulfilling to an ever increasing degree since their establishment. Upon this huge area can be found almost any type of recreational activity that may be desired from the highly developed golf facilities at Caledonia along the Lincoln Highway to the real wilderness hiking which can be obtained in some sections of the Sprout, Elk and Susquehannock State Forests miles from any human habitation.

HUNTING AND FISHING

For those who hunt and fish, the State Forests will be found to be in truth a sportsmen's paradise. With the exception of isolated tracts that have been set aside as game refuges and as recreational centers, this entire area of more than one and one-half million acres is open to hunters. It is interesting to note that although the State Forests comprise only about one-eighth of the wildland of the State, yet usually more than one-half of the deer and one-third of the bears killed in Pennsylvania are gotten on the State Forests.

Flowing through State Forest land are some of the finest trout streams in the East. Within the past year a decided effort has been made by the Department to improve the streams for fishing by the building of small dams, the erection of barriers, and other artificial means to aid in the propagation of fish.

PERMANENT CAMP SITES

Under the provisions of an Act approved on March 27, 1913, the Department of Forests and Waters is permitted to lease small parcels of State Forest land to residents of Pennsylvania for health and recreation. By law the leases are limited to ten years, and by policy to any area usually not exceeding one-quarter of an acre. The popularity of this form of camping privilege is demonstrated by the increase in the number of sites from 37 in 1914, to 1122 in 1924 to approximately 3000 at the present time.

At the outstart these sites were used principally by hunting and fishing parties. In recent years, however, an ever increasing percentage is utilized for summer homes. Thousands of persons are thus enabled to enjoy at moderate cost the beneficial influence of a forest environment during the summer season and at various other times throughout the year. Upon most of the sites, buildings have been erected, representing in the aggregate an investment of several millions of dollars.

STATE FORESTS OF PENNSYLVANIA

<i>District</i>	<i>Headquarters</i>
Michaux	Caledonia State Forest Park, Fayetteville R. D. 2, Franklin County
Buchanan	McConnellsburg, Fulton County
Tuscarora	Blain, Perry County
Rothrock	Welch Building, Mt. Union, Huntingdon County
Logan	2 Kind Street, Petersburg, Huntingdon County
Penn	Milroy Bank Building, Milroy, Mifflin County
Bald Eagle	Boro Building, Mifflinburg, Union County
Mont Alto	Mont Alto, Franklin County
Moshannon	County National Bank Building, Clearfield, Clearfield County
Sproul	118 Sixth Street, Renovo, Clinton County
Harrisburg	State Education Building, Harrisburg, Dauphin County



FISHING IN ONE OF THE MANY WELL STOCKED TROUT STREAMS IN PENN'S WOODS

Tiadaghton	Herman Building, Williamsport, Lycoming County
Elk	Fourth Street E. of Broad, Emporium, Cameron County
Cornplanter	Bell Oil and Gas Building, Warren, Warren County
Susquehannock	Second and East Streets, Coudersport, Potter County
Tioga	Old First National Bank, Wellsboro, Tioga County
Valley Forge	Montgomery Trust Arcade Building, Norristown, Montgomery County
Weiser	6 N. Center Street, Pottsville, Schuylkill County
Delaware	618 Main Street, Stroudsburg, Monroe County
Wyoming	American Legion Building, Bloomsburg, Columbia County
Lackawanna	316 Washington Ave., Scranton, Lackawanna County
Forbes	Ligonier, Westmoreland County
Gallitzin	Swank Building, Johnstown, Cambria County
Kittanning	Main Street and Sixth Ave., Clarion, Clarion County



ONE OF THE THREE THOUSAND PERMANENT CAMP SITES IN THE PENNSYLVANIA STATE FORESTS

THE STATE FOREST PARKS

For those who love the outdoors and yet do not enjoy so much the "wild and woolly" regions, for those who prefer not to stray too far from the beaten path, for those who because of age or infirmity or merely from personal inclination, do not care to "rough it," there have been established in all the State Forests, a series of recreational areas, public camp grounds, and picnic areas, where a taste of the woods may be obtained without encountering its hardships.

Although practically all State Forest land is used to some extent for recreational activities there are certain areas of greater or less extent that are particularly adapted for this purpose. Nine of these have been designated as State Forest Parks. In several cases, natural beauty is the predominant charm, intensified by conditions which contribute to its enjoyment; in others, historical associations with settings that are especially favorable to group recreation constitute the chief attraction; in still others, topographical and other natural features have combined with convenient locations and the addition of facilitating structures to make them areas of great popularity among those seeking enjoyment in the great outdoors.

An effort has been made to inform the visitor of the possibilities of the surrounding region by means of guide signs indicating the location of roads, trails, points of historic interest, picturesque views, forest fire observation stations, interesting tree plantations, and individual trees.



TOURIST CAMPERS IN THE CALEDONIA STATE FOREST PARK

At all these State Forest Parks, pure water, fireplaces, shelters, picnic and camping grounds, tables, benches, playgrounds, and toilet facilities have been provided. Swimming is available at Sizerville, Childs, Cole-rain and Greenwood.

At the present time eight areas in addition to those hereafter described are being developed as State Forest Parks—Parker Dam in Clearfield County, Halfway in Union County, Riansares in Clinton County, Black Moshannon in Centre County, Worlds End in Sullivan County, Pine Grove Furnace in Cumberland County, Promised Land in Pike County, and Blue Hole in Somerset County. Dams are either now under construction or have been completed at these sites which will provide splendid swimming. Other necessary facilities and equipment will also be installed.

CALEDONIA STATE FOREST PARK

Franklin County

The Caledonia State Forest Park is one of the most beautiful spots in the South Mountains, a region widely known for its scenic charm. It is a favorite picnic ground for local residents and is used extensively by transcontinental tourists.

The park is named for the old charcoal iron furnace, part of which is still in existence, that was established in 1837 by Thaddeus Stevens



PUBLIC GOLF COURSE AT CALEDONIA STATE FOREST PARK

THE STATE FOREST PARKS

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TOURIST CAMPERS IN THE CALEDONIA STATE FOREST PARK

At all these State Forest Parks, pure water, fireplaces, shelters, picnic and camping grounds, tables, benches, playgrounds, and toilet facilities have been provided. Swimming is available at Sizerville, Childs, Cole-rain and Greenwood.

At the present time eight areas in addition to those hereafter described are being developed as State Forest Parks—Parker Dam in Clearfield County, Halfway in Union County, Riansares in Clinton County, Black Moshannon in Centre County, Worlds End in Sullivan County, Pine Grove Furnace in Cumberland County, Promised Land in Pike County, and Blue Hole in Somerset County. Dams are either now under construction or have been completed at these sites which will provide splendid swimming. Other necessary facilities and equipment will also be installed.

CALEDONIA STATE FOREST PARK

Franklin County

The Caledonia State Forest Park is one of the most beautiful spots in the South Mountains, a region widely known for its scenic charm. It is a favorite picnic ground for local residents and is used extensively by transcontinental tourists.

The park is named for the old charcoal iron furnace, part of which is still in existence, that was established in 1837 by Thaddeus Stevens



PUBLIC GOLF COURSE AT CALEDONIA STATE FOREST PARK

who was famous as an abolitionist and statesman during the Civil War era, and who was the great defender of the public school system of Pennsylvania. The iron furnace and other properties were destroyed during a raid by General J. A. Early's Confederate cavalymen in June, 1863. Today all that remains of this thriving industry is the stack of the old furnace, upon which has been placed a bronze tablet commemorating the historical associations of Caledonia, and the walls of the blacksmith shop which has been repaired and which now serves as park headquarters.

Within the park area of 260 acres is a camping ground where complete facilities and conveniences for the public are provided. An excellent bathing pool and public golf course are available for park visitors.



A POCONO WATERFALL IN THE CHILDS STATE FOREST PARK

GEORGE W. CHILDS STATE FOREST PARK

Pike County

No mere picture can adequately portray the exquisite beauty of the three falls at Child's State Forest Park in Pike County. Although, of course, lacking the height, width and volume of Niagara, nevertheless the background and setting are such as to make them gems of beauty far surpassing many better known and much more highly advertised waterfalls in other States.

The park area of 52 acres was deeded to the Commonwealth of Pennsylvania by George W. Childs, for many years editor and publisher of the *Philadelphia Public Ledger*, who purchased this well watered, beauti-

ful forest tract which he bequeathed to the State upon his death. Well equipped facilities for camping are maintained within the park. Good fishing and swimming may be enjoyed.

VONEIDA STATE FOREST PARK

Centre County

The Voneida State Forest Park (also known locally as Hairy Johns) is one of the most popular woodland recreational areas in central Pennsylvania. In order to accommodate visitors from all over the State who come here to enjoy the forest environment, the park has been enlarged to 100 acres.

It is named for a picturesque mountain hermit, John Voneida, who formerly lived near the site of the park. A favorite grounds for picnickers, the park contains a spring of excellent cold mountain water. Many attractive summer homes and hunting camps have been erected in the State Forest adjoining the park on land leased from the Department of Forests and Waters.

LEONARD HARRISON STATE FOREST PARK

Tioga County

Let every admirer of outdoor beauty go some time to Leonard Harrison State Forest Park in Tioga County. Standing upon a little lookout rock, he will find a sheer drop below him of hundreds of feet and will look with awe into that mighty chasm yawning at his feet. Far beneath winds the picturesque Pine Creek seeming at the distance only a miniature brook, and beside it what looks like a toy railroad train, as it puffs along the stream. Then upon lifting the gaze to the level he will behold the successive mountain tops of unbroken wilderness finally vanishing in the distance.

Leonard Harrison of Wellsboro donated the land, upon which this park is situated, to the Commonwealth for recreational purposes. Adjoining the park are some of the finest hunting grounds and fishing waters to be found in Pennsylvania. Big game animals such as deer and bear are to be found within this territory. Small game animals and bird life are particularly abundant. Facilities for camping and outdoor recreation have been provided within the 140 acres of park area.

COLERAIN STATE FOREST PARK

Huntingdon County

The Colerain State Forest Park derives its name from the old Colerain Forge, which for many years stood a short distance from the park and which was one of the famous iron forges of central Pennsylvania. Although only 4 acres in area the park is beautifully located along Spruce Creek, an excellent trout stream. A winding forest trail connects this park with Ice Cave Gap, where natural ice may be found throughout the year. The park is popular as a picnic area and camp grounds.

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GREENWOOD STATE FOREST PARK

Huntingdon County

Deriving its name from the Greenwood Furnace whose stone ruins mark an important period in the great iron industry in Pennsylvania, the Greenwood State Forest Park of 120 acres is popular, not alone for its facilities for picnicking, boating, and swimming, but also because the Greenwood State forest tree nursery, operated by the Pennsylvania Department of Forests and Waters, is located here. The nursery has an annual production of approximately two and one-half million forest tree seedlings and transplants. An excellent view of the mountains of Huntingdon, Mifflin, and Centre Counties may be obtained from the Greenwood Forest Fire Observation Tower on Broad Mountain north of the park.

MONT ALTO STATE FOREST PARK

Franklin County

The Mont Alto State Forest Park containing 20 acres, has been for many years a favorite recreational center in southern Pennsylvania. Developed by Colonel George B. Wiestling for the old Mont Alto Iron Company the park was later operated by the Cumberland Valley Railroad. The Mont Alto Iron Company, whose furnaces were formerly located nearby, owned thousands of acres of mountain land, now largely included within the Mont Alto State Forest.

Adjoining the park is the Pennsylvania Forest Research Institute, maintained by the Pennsylvania Department of Forests and Waters for conducting forest research studies, and the Pennsylvania State Forest School operated by the Pennsylvania State College, where freshmen and ranger forestry students receive instruction.

The Mont Alto State Forest nursery, which covers about twelve acres and which has an annual production of approximately four million forest tree seedlings and transplants, is also located here. The trees raised in this nursery are distributed by the Pennsylvania Department of Forests and Waters for reforestation in the State Forests and on privately owned land.

At the eastern end of the park is the beautiful Traveler's Spring where tables, shelters, fireplaces, and pure water are available for picnicking.

SIZERVILLE STATE FOREST PARK

Cameron County

The Sizerville State Forest Park containing 200 acres, has an excellent swimming pool available for the free use of the public. Nearby is a large spring from which flows mineral water reputed to have medicinal value.

About 100 miles of roads and trails make the adjoining State Forest accessible for hiking, hunting, and fishing. Some of the finest fishing streams of northern Pennsylvania are within a short distance of the park. Excellent views of the dense forest region within which the park is situated may be obtained from the Fox Mountain Forest Fire Observation Tower, with an elevation of 2,400 feet, which is four miles from the park.

HEMLOCKS STATE FOREST PARK

Perry County

The Hemlocks State Forest Park, embracing a splendid stand of original hemlock, the State Tree of Pennsylvania, has been widely known in the past few years, not only for its great trees and picturesque surroundings, but also because of the great daybreak song-service held each year and attended by thousands. Here is a picturesque mountain gorge and a cool rushing stream, typical of the original Penn's Woods before the ancient forests fell before the axe of the lumberman.

This park of 30 acres, has been maintained in its natural state; the usual comfort facilities which are standard equipment at the other State Forest Parks have not been developed here. The visitor to this park may enjoy a day in the wild woods among veteran hemlocks and pines where the charms of a wholly natural environment are sufficient attractions for those who like to rough it when they go into the out-of-doors.

THE STATE FOREST MONUMENTS

The State Forest Monuments are spots of unusual scenic beauty, of historical association, or of unique botanical or geological distinction set aside by action of the State Forest Commission in perpetuity for the use and enjoyment of the citizens of this and other States. Eleven such areas have been established. They comprise in each case a remnant of the superb forests which once covered the greater part of the Keystone State. These monuments are not intended primarily for camping or for picnic purposes, but in each instance, either on the area itself or within a reasonable distance, provision has been made for the comfort of visitors.

OLE BULL STATE FOREST MONUMENT

Potter County

Ole Bull, the famous Norwegian violinist, in 1852 attempted to found a colony of his countrymen, in the Black Forest of Pennsylvania along the waters of Kettle Creek. Upon the summit of a mountain, overlooking the valley where the settlements of the Norwegians were begun, are the stone ruins of Ole Bull's castle. A motorist driving between Oleona and Cross Fork may see on clear days the flags of the United States and Norway flying from the site of the castle walls.

JAMES BUCHANAN STATE FOREST MONUMENT

Franklin County

The James Buchanan State Forest Monument marks the birthplace of James Buchanan, fifteenth President of the United States, the only Pennsylvanian to occupy the presidential chair. Although the small home in which he was born has been removed to Chambersburg, a stone pyramid twenty-five feet high set among Norway spruce trees, marks the place where the house stood. A well equipped public camp ground is located at the entrance of the monument in a beautiful grove of hemlocks.



THE BIRTHPLACE OF A PRESIDENT: THE JAMES BUCHANAN STATE FOREST MONUMENT

JOYCE KILMER STATE FOREST MONUMENT

Union County

Twenty-one acres of old hemlocks and white pines on the north slope of Paddy Mountain comprise the Joyce Kilmer State Forest Monument, named for the young American poet who was killed in France during the World War, the author of the world-famous poem "Trees." A beautiful forest trail leads to the top of the mountain and to a natural amphitheatre formed by a circle of large boulders over-hung by gigantic hemlocks.

BEAR MEADOWS STATE FOREST MONUMENT

Centre County

If interested in Nature from a purely scientific standpoint, a trip to the Bear Meadows State Forest Monument will amply repay the visitor. A great quagmire of 350 acres in extent, it is a veritable botanists' paradise with its abundance and variety of vegetation, many specimens being found nowhere else in the State.

Many students of botany and forestry conduct field studies in the great forested meadows. Among their interesting features are numerous fine springs, abundant and often impenetrable thickets of laurel and rhododendron, and dense growth of young coniferous trees.

SNYDER-MIDDLESWARTH STATE FOREST MONUMENT

Snyder County

One of the largest bodies of original timber within the State Forests of Pennsylvania is found in the Snyder-Middleswarth State Forest Monument, comprising 425 acres of veteran hemlocks, white and pitch pines, and hardwoods. Within the monument area are 250 acres which have been untouched by the lumberman's ax and which constitute a picturesque remnant of the original Penn's Woods.

Swift Run and other nearby streams are favorite haunts of fishermen. A plentiful supply of pure water and adequate camping facilities are provided for the convenience of the public. The park was named for two prominent old families. Simon Snyder was the third Governor of Pennsylvania; Captain Ner Middleswarth was a distinguished officer of the War of 1812.

DETWEILER RUN STATE FOREST MONUMENT

Huntingdon County

A Pennsylvanian wishing to obtain a conception of the primeval forests of the State cannot find anywhere conditions more typical of the original Penn's Woods than those in the Detweiler State Forest Monument with its great white pines and hemlocks and dense under-growth of conifers, rhododendrons, and hardwoods.

Local history has it that wolves, which have long been extinct in Pennsylvania, made one of their last stands in the gloomy depths of Detweiler Hollow. The dark recesses of this forest are the homes of numerous birds and animals. Beautiful Detweiler Run flows through the center of this tract.

ALAN SEEGER STATE FOREST MONUMENT

Huntingdon County

Hemlocks, pines, and oaks of unusual size and beauty and magnificent thickets of rhododendron bordering the forest streams are to be found within the Alan Seeger State Forest Monument, which was named for the young American poet who lost his life in France during the World War. Within the monument there is a well equipped camping ground with an abundance of pure water.

The Monument is adjacent to the Detweiler Run State Forest Monument.

MCCONNELL NARROWS STATE FOREST MONUMENT

Union County

Some of the most magnificent rock scenery in Pennsylvania as well as stands of great hemlocks and white pines are to be found in the McConnell Narrows State Forest Monument. The monument is located on the southern slope of White Mountain whose colossal white rocks afford shelter to many wild animals. Excellent canoeing, swimming, and fishing may be had in Penn's Creek.



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THE PICTURESQUE SINNEMAHONING CREEK FLOWS THROUGH THE SPROUL STATE FOREST

MOUNT LOGAN STATE FOREST MONUMENT

Clinton County

Named for the great Indian orator, Chief James Logan, the Mount Logan State Forest Monument contains many superb coniferous trees whose inaccessibility saved them from the lumbermen. Close to the foot of Mount Logan is Camp Shoemaker, a grove of five acres having excellent camping facilities. Shoemaker Park, a public camping ground with outdoor stoves, tables, and running water, is nearby.

MOUNT RIANSAIRES STATE FOREST MONUMENT

Clinton County

This forest monument was named for the Duke of Riansares, husband of Maria Cristina, former Queen of Spain, who owned timber and coal lands in Pennsylvania and who directed that the highest peak of her Pennsylvania possessions be named for her husband. From the summit of Mount Riansares may be had a magnificent view of the surrounding forest territory. A forest fire observation tower is located on the highest ridge.



A TEMPORARY HUNTING CAMP DEEP IN A STATE FOREST

MARTIN'S HILL STATE FOREST MONUMENT

Bedford County

Martin's Hill is one of the highest peaks of southern Pennsylvania. Within a gorge of this mountain among a stand of superb hemlocks is the Martin's Hill State Forest Monument. A steep path leads from the monument to the mountain top upon which is a forest fire observation tower where magnificent views may be had.

THE STATE FOREST PUBLIC CAMPS

In addition to the accommodations for camping and picnicking at the State Forest Parks and State Forest Monuments as previously mentioned, 46 sites in the State Forests of Pennsylvania have been set aside specifically for these purposes. They are termed State Forest Public Camps. Tables, benches, pure water, shelters, fireplaces, and toilet facilities have been provided. These sites are very popular, especially among those who wish to avoid the crowds that ordinarily are found in the State Forest Park, particularly on holidays and over week-ends in the summer months. The following list gives the location of the State Forest Public Camps.

<i>State Forest Public Camps</i>	<i>County</i>
Brooke	Berks
Blankley	Bedford
Old Locust	Centre
McCall Dam	Centre
B. F. Krumrine	Centre
Smith	Clearfield
S. B. Elliott	Clearfield
Old Town Tower	Clearfield
Tea Springs	Clinton
Jesse Hall	Clinton
Ravensburg	Clinton
Laurel Forge	Cumberland
Sprow's Run	Cumberland
Big Pond Furnace	Cumberland
Old Forge	Cumberland
Stillhouse	Franklin
Bear Valley	Franklin
Tuscarora	Franklin
Sideling Hill	Fulton
Cowan's Gap	Fulton
Jerry Spring	Fulton
Whipple Dam	Huntingdon
Clear Creek	Jefferson
Cornwall	Lebanon
Upper Pine Bottom	Lycoming
Laurel Run	Mifflin
Colonel Denning	Perry
Kansas Valley	Perry
Big Spring	Perry
Burley Point	Pike
Peck's Pond	Pike
Ridgefield Point	Pike
Patterson	Potter
Cherry Springs	Potter
Prouty Place	Potter
Kooser	Somerset
McCloskey	Somerset
Rock Springs	Snyder
Darling Run	Tioga
Morris	Tioga
Eastville Gap	Union
Hickernell Spring	Union
Sand Ridge	Union
Buffalo Path	Union
Adams Falls	Westmoreland
Laurel Summit	Westmoreland

GREATER RECREATIONAL AREA NEEDED

In the efforts of the Commonwealth to place proper and valuable recreational and health facilities at the disposal of its people, there is, however, something lacking. The historical State Parks, the State Forest Parks, and the State Forests themselves serve admirably the purposes for which they were severally intended. The great outstanding need at the present time, however, seems to be the establishment of a supplementary system of State-owned land located near the centers of population and intended primarily for recreational use.

There are within easy distance from most of the larger cities of Pennsylvania, natural areas of unusual scenic beauty such as waterfalls, gorges, caves, rapids, impressive views that could and should be owned and managed as State Parks or included with the State Forests. Pennsylvania is blessed with places of monumental beauty, places that are an integral part of her greatness. These need to be made accessible and available to the masses of her citizens.

Authorities contend that there should be an average of not less than 10 acres of recreational land per thousand population within a 30-mile radius. The proportionate present park area within a 30-mile radius in the Philadelphia area is only less than two acres per thousand; in the Scranton-Wilkes-Barre section, not even as much; in the Pittsburgh area, a little more than two acres.

Stated in acres, the present minimum need in the Philadelphia area is 23,000 acres; in the Pittsburgh section 14,000 acres; in the hard coal regions, 17,000 acres; in the State as a whole 96,000 acres. In formulating a comprehensive plan for the future, however, certainly this figure must be considerably more than doubled. It should be understood that this refers specifically to land whose primary use would be recreation.

To some extent the deficiency in the Philadelphia and Pittsburgh regions will be met by the park areas being established by the Federal government in the French Creek and Raccoon Run sections. It is the expectation that after these recreational areas are fully developed, they will be turned over to the Commonwealth to be managed and administered as State Parks. Numerous similar areas should be located in various other sections of the State.

Part of the remaining deficiency in the State at large could be supplied in the form of additional State-owned parks and part in additional State Forest land that could be made available for rather intensive development. From a purely forestry standpoint there is a great need for more State Forests—probably treble the present holdings.

In most other things, tangible or intangible, material or otherwise, Pennsylvania is usually found well up among the leaders if indeed not actually in the van. In the number and acreage of State parks, however, this great Commonwealth does not compare so favorably with a number of other States, some of them far less blessed in wealth and resources. Why? Presumably because for some reason or other the great mass of citizens has not had the importance of State Parks impressed upon them, because they have not become park-minded as have the residents of New York, Indiana, Connecticut, and other sister States.

It is unquestionably true that through the Pennsylvania Parks Association and similar agencies, through the efforts of interested individuals, the attitude of Pennsylvania toward the so-called park movement is

changing and there is reason to believe that in the near future the Keystone State will be actively engaged in increasing and improving the State park system. There are three indications of this trend.

In the 1931 Legislature, for the first time an appropriation for the purchase and maintenance of State park lands (other than those already established) was approved. Unfortunately the Governor was compelled to cut this appropriation heavily because of the anticipated reduction in revenues and only sufficient funds were approved to permit the maintenance of the Delaware Canal or, as it is now called, the Roosevelt State Park. This, however, was a step in the right direction and has placed upon the statute books a token of an interest in the project on the part



SCENIC VIEWS ARE PART OF PENNSYLVANIA'S FOREST HERITAGE

of those in authority. With the return of better times, funds which will permit the purchase of additional park lands will doubtlessly be forthcoming.

The second indication of the present trend was in 1933 when the proposal to create the Bucktail State Park received legislative and gubernatorial approval. Under this act a large area extending along the Susquehanna River from Lock Haven to Emporium, and from mountain rim to mountain rim across the valley, is to be set aside as a State Park, provided that the private land owners are willing to cooperate in permitting the State to administer the entire area as a State park for the best interests of the various communities as a whole without regard for individual desires.

The third is the comparatively recent donation of one tract of land and the offer of two others by owners who are actuated entirely by a desire to further the park movement and have nothing whatever to gain personally except perhaps the satisfaction of aiding what they deem to be a worthy cause. The property of which the Department of Forests and Waters has already taken possession is the Ralph Stover Tract which has been described. The other two are in the opposite end of the State, in Fayette County. A number of months ago the Fort Necessity Chapter of the Sons of the American Revolution, Uniontown, offered two proper-



BEAUTIFUL PROMISED LAND LAKE IN THE DELAWARE STATE FOREST

ties to the Department of Forests and Waters, with the provision that they be developed as State Parks within a reasonable time.

The one was an area of about 44 acres containing the grave of Jumonville, the young ensign who commanded the French soldiers in the brief skirmish in which George Washington was first under fire several days before his first real battle at Fort Necessity. This area has additional historical significance as Braddock's road crosses the driveway entering the area while nearby is the site of Dunbar's camp.

The second tract which has been offered to the Department contains the present grave of General Braddock, his original place of burial, and a portion of the Braddock road. The property comprises 27 acres and lies immediately adjacent to and north of the National Highway, and

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just a few miles west of Fort Necessity. Both these areas could be developed into very valuable additions to the State park system. It is hoped that funds will soon be available to do the necessary work and that title can then be transferred to the Commonwealth.

PUBLIC COOPERATION

A most important phase in this State Park project is the need for cooperation on the part of the people of the State. By cooperation is meant not merely assent or passive interest, but active and emphatic aid and assistance. A survey made some months ago revealed the fact that Pennsylvania was near the bottom of the list in the amount of acreage which had been contributed by her citizens for use as State parks. In a number of other States, many of the choicest sites had come into common ownership through the donations of interested citizens.

It is to be hoped that as time elapses it will be possible to secure the support of many public-spirited men and women who are able and willing to contribute to this worthy cause. For surely it is worthy, not only from an aesthetic or idealistic point of view, but also from an entirely practical or even selfish standpoint. It is not generally realized how large a percentage of all taxes is expended in the maintenance of penal and corrective institutions for the care of those who are broken down physically, mentally, or spiritually and who as a result have become public charges. Prevention is far cheaper and much more effective than rehabilitation. Who will doubt that State park development can be made an important agency in the localities of dense population in creating sturdiness of body and character among those who need just that sort of aid?

Or take another phase of the problem—the tourist trade. A study of statistics will soon convince anyone who is skeptical that Pennsylvania is not getting her proportionate share of the tourist business although inherently better equipped than many of her competitors. More State parks could be made the biggest single factor in developing a more favorable tourist trade balance for the Commonwealth.

And so it can be seen that this matter of leisure time is not a simple proposition, but really a complex problem with many angles of approach and numerous divergent phases. In the final analysis, however, there seems to be no question as to its importance. Doubtlessly the solution will be a gradual one but its beginning must be early—now—if it is to be attended by the fullest measure of success.

There must be complete cooperation among all of the various agencies involved. There must be coordination of effort in encouraging the beneficial use of spare moments in the home, at school, at work, in the city and in the great outdoors.

It is, of course, the latter phase in which the Department of Forests and Waters is particularly interested and naturally the one in which it is best able to assist. As far as its resources will permit, it will take all possible steps to meet the situation and be prepared to do its share in solving this leisure time problem, in the hope and expectation that in so doing the progress of this nation may not be retarded, but that it may move with exhilarated step toward that bright and brilliant future to which all patriotic citizens look forward with confidence and assurance.

Replacement
of the
Chestnut
in
Pennsylvania

By John E. Aughanbaugh



Bulletin 54

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF FORESTS AND WATERS

Ralph M. Bashore, *Secretary*

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INTRODUCTION

The loss of chestnut has brought forcibly to the attention of foresters various problems most difficult of solution. Chestnut possessed qualifications which justified its recognition as one of the most valuable tree species adapted to Pennsylvania forestry. Especially outstanding were its rapid growth, its adaptation to relatively poor, dry sites, its ability to reproduce prolifically from sprouts, the extensive use of its durable wood for many products, and the food value of its nuts for the wild life of the forest. A tree species, growing abundantly over an extensive area and possessing these desirable qualities, cannot pass out of existence, as did chestnut because of the blight disease, without seriously complicating the forestry program with difficult economic, silvicultural, and biological problems.

As foresters face this situation, many questions arise. Will chestnut eventually win out in its struggle against the blight, because of its remarkably persistent sprouting habit? Even the optimists who predict that this may happen must admit that at best chestnut timber cannot again become a factor of importance in Pennsylvania for many years. What is Nature doing to fill the millions of gaps and openings in Penn's Woods caused by the death of the chestnut? Are the replacement species desirable, capable of good growth, and suitable for valuable products? Can they take the place of chestnut as a wood for general use? If not, what can the forester do to encourage better natural reproduction, or to introduce new species?

When we consider these questions, we realize that the study of chestnut replacement is not merely a subject of academic interest, but a problem of great importance from the standpoint of practical and profitable timber production. Moreover, the scope of the problem is not limited to the present openings in the forest caused by the death of the chestnut, but involves all silvicultural practices dealing with the management of the extensive oak-chestnut-hard pine type. Therefore, the Pennsylvania Forest Research Institute has initiated this study of chestnut replacement as the preliminary effort to solve the problems of rehabilitation, regeneration, and management of this important forest type.

PENNSYLVANIA LOSES A VALUABLE TREE

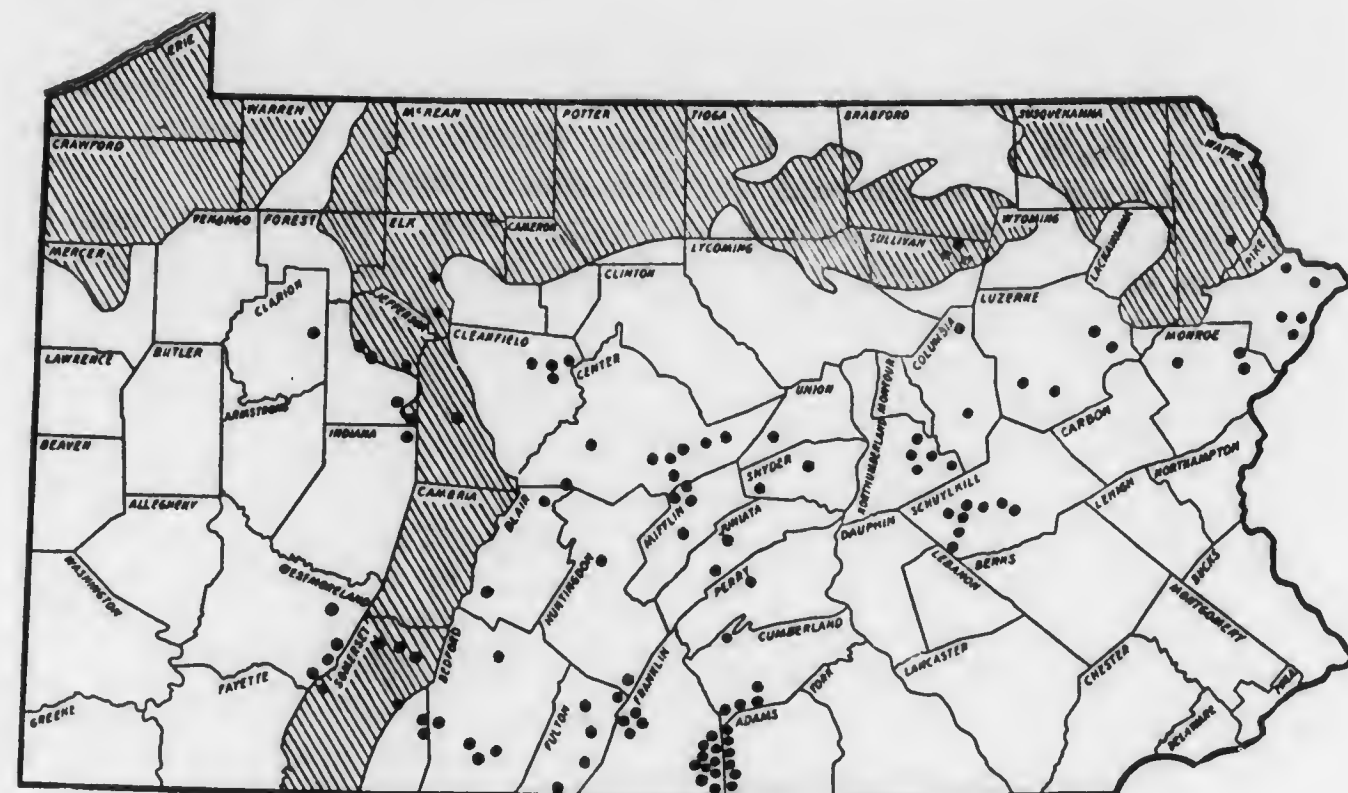
Like the invasion of an army, the chestnut blight moved relentlessly through the forests of Pennsylvania, leaving a path of destruction in its wake. In the wrecked woodlands that remain in many sections, there is little which recalls to mind the fine young stands of timber so common previously. Still outlined against the background of the forest stand those gaunt white skeletons of the chestnut as grim reminders of the catastrophe.

Progress of the Chestnut Blight

Twenty-five years have elapsed since the blight fungus (*Endothia parasitica*) was first discovered in southeastern Pennsylvania, in 1909. By 1915 it had progressed westward as far as Lycoming County in the north and Bedford County on the southern border, with some advance spot infections penetrating even farther. Thus in the comparatively brief span of six years practically all chestnut in the entire eastern half of the State was infected. From there westward the high ranges and intervening valleys of the Allegheny Mountains, coupled with the prevailing west winds, retarded but could not prevent its spread. By 1920 the blight was present in the southwestern counties and advancing gradually into all remaining uninfected areas.

This outlines briefly the progress of the most serious natural calamity which ever befell the forests of Pennsylvania. The nature of the disease meant slow lingering death for the chestnut, covering an average period of five to ten years

from the time the blight first appeared in a given locality. Recent reports indicate that the blight has extended to the extreme limits of the natural range of chestnut within the United States (11). All efforts to discover a cure for, or an effective means of preventing the spread of this disease, in Pennsylvania and elsewhere, have been futile. It therefore is probable that in the near future all commercial stands of American chestnut will have been destroyed.



STUDY AREAS IN CHESTNUT REPLACEMENT.

The black dots show the location of study areas, representing 28 counties of the State. Unshaded portion shows distribution of the oak-chestnut-hard pine type of forest; shaded areas represent distribution of the beech-birch-maple forest type.

Occurrence of Chestnut in Pennsylvania

Chestnut was always regarded as the most common forest tree in Pennsylvania (16). It was found in every county in the State, although the central, eastern, and southern sections contained the largest quantities. Before the blight made its appearance this species comprised from 10 per cent to more than 50 per cent of the standing tree volume over vast areas. In the best parts of its range it was not uncommon to find local areas where chestnut constituted 90 per cent of the stumpage.

Chestnut very seldom occurred in extensive pure stands: it usually preferred the association of that group of trees known as the oak-chestnut-hard pine type. Of the major forest types now recognized in Pennsylvania, no other has a wider distribution than the one in which chestnut was most commonly present (see map above). Second in area is the beech-birch-maple type, in which recent studies have indicated that chestnut constituted an average of five per cent to ten per cent of the forest (19). With these two outstanding tree associations covering practically the entire forested area of the State, it can readily be seen that chestnut grew in mixed stands in which were represented most of our valuable timber species. To list all its common associates would, therefore, require mentioning a major portion of the 125 different kinds of trees native to Pennsylvania.

Since chestnut had such a wide natural distribution, it can be assumed correctly that it was not an exacting species. It could grow thriftily on almost any type of well-drained soil, except limestone. Although it occurred on all sites, from coves to

mountain tops, the tree undoubtedly predominated on the slopes. Southern slopes with a sandy or gravelly loam or shale soil probably represented its optimum development in Pennsylvania.

Chestnut a Useful Tree

Before the appearance of the blight, chestnut was regarded as one of the most important timber trees of Pennsylvania, because of its exceptional growth characteristics and the multitude of uses to which it was adapted. There is no better way to emphasize the seriousness of its loss than to enumerate briefly some of the tree's well-known qualities.

Probably no species offered more promise of financial return from our impoverished mountain lands, comprising about one-fourth of the total forested area of the Commonwealth. Over vast stretches of relatively poor soil, this tree was able to maintain rapid growth. When present in well-stocked stands, chestnut was one of the few hardwood trees capable of producing a cord of wood per acre per year (33). Its exceptional sprouting capacity, which it retained to an advanced age, assured a satisfactory regeneration following even the most ruthless methods of timber exploitation. There is reason to believe that the amount of chestnut in Pennsylvania has increased since cutting first began, chiefly through its ability to sprout, combined with its rapid growth.

It was, without doubt, the best known nut-bearing tree of the Northern Hemisphere (15). Being truly delicious, the nuts were much sought by the wild creatures of the forest, as well as by man. The gathering and selling of chestnuts became a profitable business enterprise, for nearly every year there was produced an abundant crop.

The wood has many valuable qualities which contribute to its wide usage. It is straight-grained, light in weight, moderately strong and hard, easily seasoned, and exceptionally durable when exposed to the weather or soil. Few woods split lengthwise easier and straighter than chestnut. It has an attractive grain and is easily worked.

Chestnut is used for many purposes. From the time land was first cleared in this State it was the preferred wood for fence posts and fence rails. Under favorable conditions they have been known to last from 20 to 50 years or more. Enormous quantities of chestnut posts are still used in rural communities, although wire has, for the most part, replaced the split rails once so common. Chestnut rail fences are still favored on estates where horseback riding and fox hunting are popular sports. However, the time is not far distant when the old-fashioned worm fences, and rail fences with mortised posts, will become as rare as white pine stump fences are at present.

Ever since the first appearance of telephone, telegraph and power lines, chestnut has furnished the bulk of the poles used in Pennsylvania. Chestnut poles are comparatively light and durable, and especially suited to safe and easy climbing with lineman's spurs.

Other uses to which it was adapted were lumber for inside finish and outside construction work, ties, mine timbers, piles, slack cooperage, shingles, lath, and tannic acid wood. Manufacturers, classified among 27 industries, reported chestnut for nearly 200 separate and distinct uses within this State (6). Assuming first importance among manufactured products were boxes and crates, furniture, burial caskets, musical instruments, and agricultural implements.

In the early days, when iron furnaces were prominent in Pennsylvania, the woods in the neighborhood of forges were cut over repeatedly, on short rotations, to furnish charcoal with which to smelt the iron ore. Clear-cutting with sprout regeneration was invariably the practice followed. It was claimed that chestnut produced a fine grade of charcoal (21).

PROBLEMS ARISING FROM LOSS OF THE CHESTNUT

It is evident that the loss of a tree so important as chestnut must give rise to a multitude of perplexing problems. The fact that chestnut lent itself to the most varied usage of any timber species growing in Pennsylvania only served to accentuate the seriousness and complexity of the situation resulting from its death.



GRIM REMINDERS OF A FOREST TRAGEDY.

Millions of acres of Pennsylvania's forests are still scarred with the white skeletons of dead chestnut, to remind us of the loss of one of our most abundant and most valuable hardwood species.

Economic Problems

The problems of an economic nature assumed first importance. Forest owners have suffered a monetary loss that must be measured in terms of millions of dollars. With the supply exceeding the demand, vast quantities of dead chestnut cannot be salvaged at a profit and consequently must be left to decay in the woods. This is the inevitable result of competitive effort, among owners of dead chestnut timber, to unload deteriorating products upon an already flooded market. In many instances freight rates are entirely prohibitive (32) and practically limit the disposal of chestnut to local communities.

Such objectional features as checking, decay, case-hardening, and brittleness have greatly reduced the value of all dead standing chestnut. Where markets exist, the trees are still used for fence posts, extract wood and fuel. Since the more accessible dead chestnut has already been salvaged, it now proves difficult to dispose of the remainder at a profit, or even at cost of production.

Biological Problems

Being a complex association of many different life forms, all more or less interdependent for mutual benefit, the forest represents a symbiotic relationship of plant and animal life. The elimination of one member of this community forces a read-

justment of the natural balance which previously existed. Viewed from this standpoint, it may readily be understood that the passing of the chestnut gave rise to many important biological problems.

Wherever it occurred in the forests of Pennsylvania, the chestnut provided a staple food for squirrels, wild turkeys, ruffed grouse, deer, and many other animals. When deprived of this wide-spread source of food, the wild creatures of the forest were compelled to readjust many of their former habits of living. In certain instances it meant a migration to more favorable localities. Some sportsmen are of the opinion that squirrels, wild turkeys, and ruffed grouse in particular show evidence of decreasing numbers in Pennsylvania, due in no small measure to loss of the chestnut.

It is possible that certain former insect and fungous enemies of the chestnut may become adapted to new hosts. For example, there are records of what seemed to be chestnut blight cankers found on rock oak. We are not predicting a similar fate for this tree, but merely cite such peculiar incidents as an illustration of what may be termed "forced adaptability." Severe infestations of the two-lined chestnut borer in mixed hardwood stands occurred recently over extensive areas in Pennsylvania. Although drought undoubtedly has considerable influence on the seriousness of such attacks, nevertheless the loss of chestnut may have been an important contributing factor.

Problems in Silviculture and Forest Management

The loss of chestnut created many problems of far-reaching significance in the field of silviculture and forest management. Chestnut was undoubtedly our principal sprout-hardwood tree, as well as an ideal species for forest management. Being the key species in most forests of the oak-chestnut type in Pennsylvania, the first management plans were designed to favor it (13). Its unusual sprouting capacity and rapid growth permitted the forester to handle large areas successfully on short rotations. Close utilization was possible because of the variety of wood products that it furnished. As small-sized material could be marketed, early thinnings were a profitable undertaking (33). Clear-cutting, under the coppice system of management, represented the common method of regenerating such stands. It remains to be determined how the loss of chestnut will modify those established practices.

One of the important facts to ascertain is the new rate of growth being made by our forests since the chestnut was eliminated. Presence of this tree on the poorer sites was formerly a great redeeming feature tending to offset the low potentiality of such areas for wood production. It is doubtful if the species which replace it can maintain nearly so fast a rate of growth, even after the forests have been restored to full productivity. Under certain conditions the situation may even warrant attempts at conversion to faster-growing conifers (33). Whatever the final solution may be, it hinges on a more definite knowledge of what growth is being made by the replacement species. The loss of chestnut rendered worthless much early growth appraisal work done in hardwood stands of the oak-chestnut type. Furthermore, because of the natural thinning which resulted, it remains to be determined when and where future thinnings can be justified. Hence it now becomes necessary to investigate anew all phases of the growth and yield which will characterize our reconstructed forests of the future.

As still another phase of the situation, the passing of the chestnut increased many-fold the problems of forest protection. If not salvaged, the chestnut remains as an encumbrance on the ground, as well as a positive menace by virtue of fire, fungus, and insect hazard (24). Certainly forests that are full of dead standing timber represent a constant fire hazard. Not only does the accumulated debris add to the intensity of the flames but it also increases the difficulty and cost of extinction.

The presence of dead chestnut, particularly trees with remnants of bark still attached, is responsible for the persistence of many fires.

SCOPE OF THE REPLACEMENT STUDY

The major purpose of this bulletin is to present an accurate picture of the role being played by replacement species, after destruction of the original stand of chestnut, with special emphasis on the silvicultural aspects of the problem. Accordingly, detailed field studies were undertaken to obtain a definite knowledge of what Nature unassisted is doing to rebuild our depleted forests. The project was initiated on the Mont Alto State Forest, in the summer of 1930, and subsequently extended to other parts of Pennsylvania.

The scope of the project embraces primarily an effort to determine what species are replacing chestnut in various sections of the State, their relative abundance under different site conditions, and their rate of growth before and after death of the chestnut. Consideration is given to both advance growth and reproduction of woody and herbaceous plants, and to accelerated growth of individual species as well as of stands. Other objects of the study were to ascertain where and how to promote the progress of natural replacement with proper cutting methods, or to supplement natural regeneration by planting where justified.

From analyses of increment borings of trees of various species, standing in openings caused by the dying of the chestnut, there was revealed the story of growth acceleration following gradual release from shade and suppression. To show how elimination of the chestnut influenced diameter growth of remaining trees, over 600 borings were taken of ten associated species. Only the closest companion species of chestnut were selected for study, including rock,¹ white, red, black, and scarlet oaks, pitch and white pines, hemlock, pignut hickory, and tulip poplar. The width of each annual ring for twenty years of recent growth was measured carefully with the aid of a hand lens and engineer's scale. Average results for each of the different species were then graphed for purposes of comparison. It would have been desirable to have included red maple, black gum, black birch and a number of other species with diffuse-porous woods, had it not been for the difficulty experienced in identifying their annual rings. Records of permanent growth study plots provided information concerning the growth of stands in which chestnut was formerly present.

The data on advance growth and reproduction were secured from nearly 3,000 temporary plots in forest openings caused by death of the chestnut, supplemented by systematic observation of conditions throughout the stand representative of each study area. With a clump of dead chestnut as the center, circular plots of twenty-foot radius became a standard basis for obtaining facts relative to the replacement species. Under ordinary conditions, a plot of this size occupied conveniently most of the ground space formerly shaded by chestnut clumps of middle age and older.

For each plot thus located, a record was secured of the numerical abundance, height, diameter, and age of all species present. On the basis of age, it was possible to distinguish between advance growth (trees and shrubs present when the chestnut was living) and reproduction (seedlings and sprouts which appeared since the chestnut died). Also, on the basis of height, and with a knowledge of the growth habits of different plants, it was possible in each chestnut opening to predict with reasonable accuracy those species destined to assume dominance. Other records taken included such factors as slope, aspect and elevation, soil and moisture conditions, average age of the stand, original percentage of chestnut, and relative abundance of shrubby and herbaceous plants. Some attention was given to areas where fire or cutting were known to have occurred recently, since they often modify the future

¹ The common name "rock oak" is used in this report rather than the name "chestnut oak," to avoid confusion with chestnut.

composition of a stand, thus complicating the problem of chestnut replacement. Moreover, it is believed that the results of replacement and reproduction, which have been found typical in chestnut openings, afford a criterion upon which future management methods must be based wherever stands in the oak-chestnut-hard pine type are cut or burned.

ACCELERATED GROWTH OF REPLACEMENT SPECIES

As the blight progressed through our forests, the resulting death of the chestnut served as a gigantic natural thinning process. Where chestnut occurred scattered through the forest, conditions beneficial for both recovery and growth of the remaining stand resulted. Areas formerly supporting almost pure stands of chestnut suffered most severely, since the growing stock was seriously depleted. In all cases, however, the growth of trees closely associated with chestnut was very noticeably stimulated, due to increased light made available, more room for crown expansion, and decreased root competition.

Although the dying of the chestnut served as a natural thinning, it was decidedly different in character from artificial "man-made" thinnings. It was a relatively slow process, permitting the remaining species to adjust themselves gradually to the changed environment. As a consequence, trees which might have been harmed by sudden liberation could, under such circumstances, gradually recover from long suppression by the chestnut.

Growth of Individual Trees

As might be inferred, a wide difference in growth acceleration exists between species, and even between individuals of the same species, depending on such factors as site, percentage of chestnut in the stand, age, crown class, and ability to withstand shade. This is illustrated by the graph on page 10. It shows the stimulus exerted on diameter growth of remaining trees after loss of the chestnut.

A perusal of this graph shows that there has resulted a very marked acceleration in the diameter growth of all species left in chestnut openings. There is reason to believe that the same tendency should hold true for associated species which received no attention. This trend is consistent for trees of any diameter and crown class. It is most noticeable on the better sites and where the heaviest stands of chestnut formerly existed. The data are presented in such a manner that the influence of the dying of the chestnut can be readily traced, beginning in 1910 (before the appearance of the blight) and continuing to 1930 (ten years after all chestnut had been dead). For most species, the most noticeable growth stimulus first occurred in 1919 or 1920 (about the time that the chestnut had succumbed). Thereafter, width of the annual rings increased gradually, culminating about 1922, and then gradually diminished until 1930, when in general the rate of diameter growth had fallen back to where it was in 1919. Thus, where 40 percent of the original stand was chestnut, the growth stimulus resulting from this heavy natural thinning had apparently subsided within a period of eleven years.

Naturally there are exceptions to these generalizations, as well as modifying influences which were operative. Most of the trees studied ranged in age from 30 to 50 years—the period of maximum growth—and it is probable that at a more advanced age such diameter acceleration would not have been possible. Then too, the average diameter growth for 1930, because of the serious and prolonged drought, dropped about 25 per cent below that of 1929, and for many species the cumulative effects of the drought became most pronounced in 1931. Had the drought not intervened it is likely that the increase in diameter growth, following death of the chestnut, would not have subsided so abruptly until several years later.

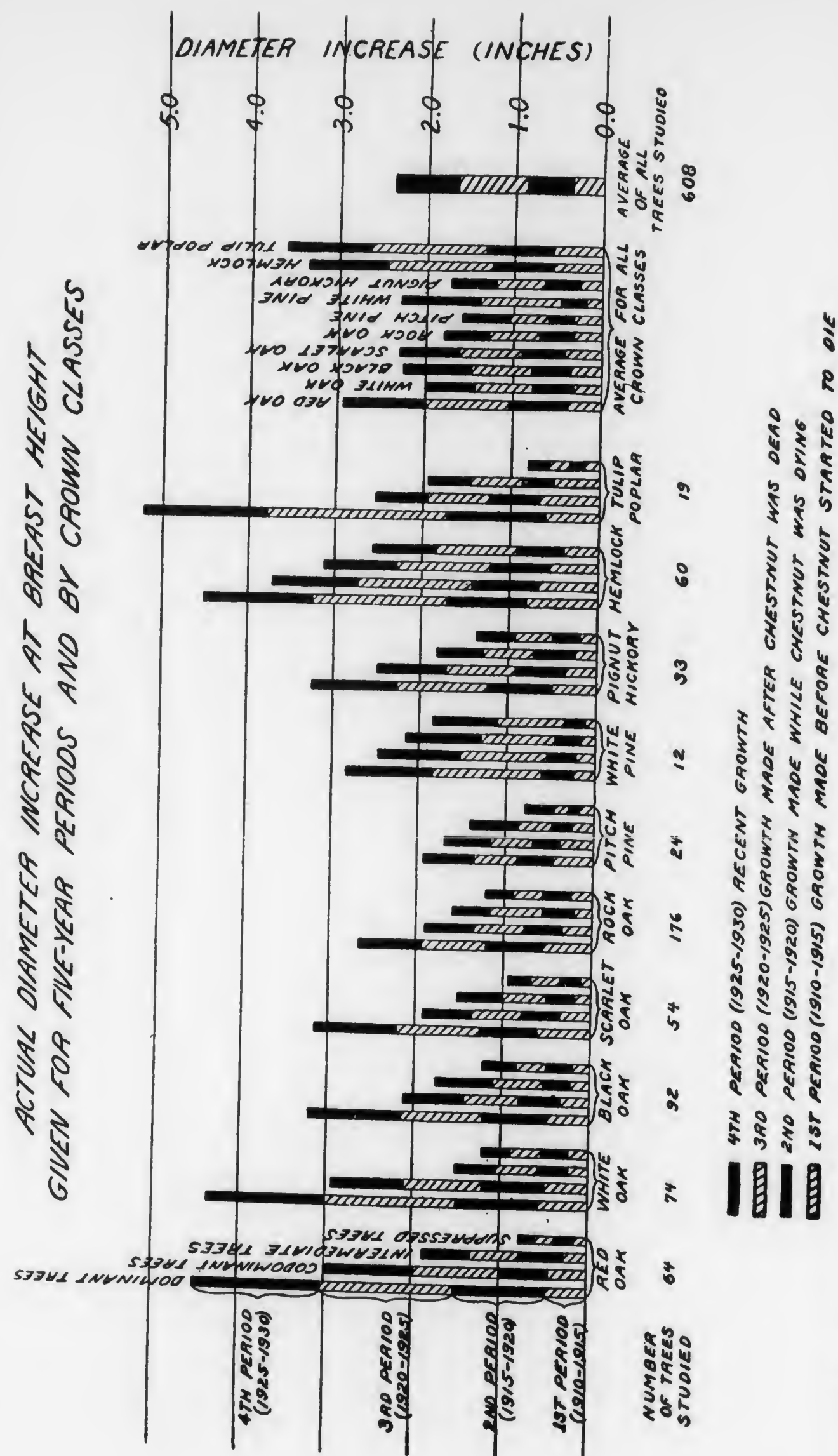


DIAGRAM SHOWING THE INFLUENCE OF THE DEATH OF CHESTNUT ON THE DIAMETER GROWTH OF ASSOCIATED SPECIES IN THE MONT ALTO STATE FOREST

Two most noticeable exceptions to the average trend are white pine and pitch pine—both intolerant coniferous species. Because of their inability to thrive under heavy shade of the chestnut, these two trees grew abnormally slowly prior to release from suppression. Even after the chestnut was eliminated it required a considerable period for them to adapt themselves to the changed environment. Hence it is noteworthy that pitch pine had not yet, in 1930, reached its culmination in growth acceleration, whereas for white pine to accomplish this required four years longer than other more tolerant hardwood species. It is quite likely that the same tendency would have held true for tulip poplar had there been more individuals representing intermediate and suppressed crown classes. However, it is a rare occurrence to find a tulip which persists after it is truly suppressed, and its dominant trees were more than able to hold their own with chestnut in the struggle for a place in the sun.

Because of its intolerance and rapid growth, chestnut was usually dominant in the forest canopy. For that reason and because of its wide distribution it was found to be useful as a site index tree (7). Its dominant position caused many other species to be held back and kept in suppression, which no doubt helps to account for the growth acceleration now shown by individual trees and stands. Rock oak is one of those trees which suffered most from its former association with chestnut. On certain areas the remaining stands of rock oak contain many trees with dead terminal shoots, and great numbers of those in the intermediate and suppressed crown classes are entirely unable to recover. In some instances the weakened condition of the trees has made them increasingly susceptible to disease.

Another direct result of the former abundance and dominant position of chestnut is revealed by the fact that height growth of the remaining trees has not kept pace with their increase in basal area. This is to be expected when the forest is opened up considerably, thus reducing the struggle for overhead light and sufficient room for crown development. However, too, some of this decreased height growth is obviously associated with an increase in age of the trees.

It is significant to contrast the per cent of diameter increase of replacement species for the ten-year period (1920-1930) after death of the chestnut with that of the previous decade (1910-1920). In this connection it should be mentioned that the blight made its appearance on the Mont Alto Forest about 1911, did not become widespread until 1915, and by 1920 all original chestnut was dead. During the recent ten-year period the per cent of diameter increase over that of the previous decade, for different species studied, is as follows: white oak 50 per cent, scarlet oak 55 per cent, rock oak 70 per cent, black oak 90 per cent, red oak 90 per cent, pignut hickory 55 per cent, pitch pine 66 per cent, hemlock 75 per cent, tulip poplar 80 per cent, whereas white pine (based on only 12 trees) outstripped all others when it registered 400 per cent—a rate of growth five times as fast as it was able to accomplish before death of the chestnut! The average diameter increase for the 608 trees of all species studied was approximately 80 per cent; or, stated in other words, it means that they grew in diameter almost twice as fast as they did before the blight had killed the chestnut. It was found that in most instances the greatest acceleration occurred within five years after the chestnut was dead.

When considered from the standpoint of volume production, the growth acceleration resulting from loss of the chestnut is even more striking. Explanation lies in the fact that the wider growth rings for the last ten years were added to a larger bole than existed at the beginning of the previous decade. Thus the volume growth of trees closely resembles a problem in compound interest, in which analogy the principal corresponds to the amount of wood capital in the tree, upon which the interest (annual or periodic increment) is regularly superimposed. Since the tree is constantly increasing in size, it becomes evident that diameter growth advances by arithmetical progression, whereas volume growth advances by geometrical pro-

TABLE 1
EFFECT OF DEATH OF CHESTNUT ON GROWTH OF STANDS OF THE OAK-CHESTNUT TYPE IN PENNSYLVANIA
(Based on Records of Ten Permanent Growth Study Plots)

Plot Description	Plot 1 Lower Slope Site Quality I	Plot 2 Lower Slope Site Quality I	Plot 3 Lower Slope Site Quality II	Plot 4 Lower Slope Site Quality II	Plot 5 Middle Slope Site Quality III	Plot 6 Lower Slope Site Quality III	Plot 7 Middle Slope Site Quality III	Plot 8 Middle Slope Site Quality IV	Plot 9 Middle Slope Site Quality IV	Plot 10 Ridge Site Quality V
Age of Stand (Years)	17	48	29	33	29	42	46	46	55	43
No. of Live Trees per Acre ¹	1000	440	832	1224	1345	600	362	968	358	850
% of Live Chestnut in Stand ²	67.9	48.6	56.4	40.9	60.5	5.3	8.9	23.8	9.0	30.3
Basal Area Per Acre (Sq. Ft.)	59.0	120.9	88.4	101.2	92.0	72.0	51.4	102.3	59.1	96.3
Volume Per Acre (Cu. Ft.)	1435.0	2936.1	2239.0	1942.7	2109.4	2018.2	1776.2	2323.2	1790.0	1620.4
Mean Annual Growth (Cu. Ft.) ⁵	84.4	61.2	77.2	58.9	72.7	48.1	38.6	50.5	32.6	37.8
Age of Stand (Years)	21	52	33	37	33	46	50	50	59	47
No. of Live Trees per Acre ¹	516	168	480	726	772	512	344	632	336	488
% of Live Chestnut in Stand ²	---	---	---	---	---	---	---	---	---	---
Basal Area Per Acre (Sq. Ft.)	25.3	63.3	47.1	62.1	46.8	71.9	60.0	88.7	72.6	56.2
Volume Per Acre (Cu. Ft.)	682.0	1785.8	1089.0	1277.3	1065.4	2067.8	1915.0	1925.2	1912.6	1131.4
Mean Annual Growth (Cu. Ft.) ⁵	73.1	61.1	71.3	56.4	68.2	47.5	38.3	49.6	32.4	37.7
Age of Stand (Years)	31	62	43	47	43	50	60	60	69	57
No. of Live Trees per Acre ¹	474	134	478	394	546	344	254	584	254	432
% of Live Chestnut in Stand ²	---	---	---	---	---	---	---	---	---	---
Basal Area Per Acre (Sq. Ft.)	62.2	81.2	64.9	70.0	55.5	87.4	64.2	87.4	84.3	65.7
Volume Per Acre (Cu. Ft.)	1463.6	2501.4	1633.8	1838.5	1343.7	2517.8	2300.0	2314.0	2311.4	1533.4
Mean Annual Growth (Cu. Ft.) ⁵	78.7	63.4	67.4	56.0	58.8	44.9	42.4	48.8	36.0	38.1
10-Year-Period After Death of Chestnut	73.2	71.6	54.5	56.1	27.8*	45.0	47.5	44.9	39.9	40.2

¹ The chestnut blight was present on all the plots at the time they were established, but it had just recently appeared and none of the trees had yet died.
² During the period (1916-1920) the chestnut was slowly dying from the effects of the blight. All of it was dead by 1920.
³ Includes all trees over one inch in diameter at breast-height.
⁴ The percentage figures are based on cubic foot volume.
⁵ Based on total wood production for the age of the stand, including chestnut.
* Remaining stand is almost pure rock oak. A disease (*Strumella corynoidea*, Winter) has become serious since the death of the chestnut and accounts for the rapid falling off in rate of growth.

gression. In the case of the 608 trees studied, their increase in cubic foot volume for the recent period (1920-1930) was almost three times that of the decade prior to death of the chestnut! Individual species varied in proportion to their growth habits, with white pine showing the greatest increase and white oak the least.

The fact that the annual rings of the replacement species are now gradually diminishing in width, after ten years or more of diameter increase, gives no reason to assume either a decrease in volume growth or a termination of the period of volume acceleration following death of the chestnut. Since current growth is being added to the circumference of a bole that is constantly increasing in size, the actual acceleration in wood volume may not subside until many more years have elapsed. The facts revealed by this study of growth acceleration provide an excellent demonstration of the practical value of thinning.

Growth of Stands

Within certain limits, it is reasonable to assume that the volume growth of forest stands has been influenced in a manner similar to that of the stimulated individual trees measured in chestnut openings. Such is not altogether the case, however, for although individual trees standing near the spaces vacated by chestnut now show greatly increased diameter and volume growth, only a limited number of trees per acre is thus affected. Since most of chestnut's common associates are relatively slow growers, even doubling their diameter growth does not produce very striking results, especially when one considers the understocked condition of the stand.

Observation shows that the replacement species are fast expanding their crowns into the openings in the forest canopy left by chestnut. The extent to which they are filling the blanks depends largely on the amount of chestnut formerly present in any particular locality. Where it constituted but a small fraction of the stand, its associates already have obliterated all traces of its former presence. In such instances the crown cover of the dominant stand is now completely closed, again establishing normal forest conditions. This is particularly true in coves and on better sites occupied by fast-growing species. Since the openings have been filled, further reproduction, especially of intolerant trees, has been effectively checked. Where chestnut composed up to 50 per cent of the standing tree volume, its companion species have been able, through extension of their crowns, to close partially most of the openings which it formerly occupied. Only where chestnut made up more than half of the forest, as it did frequently on mountain slopes in central and southern Pennsylvania, do there still exist large blank spaces unoccupied by tree growth.

However, with loss of the chestnut vast areas of our forests became seriously depleted. Their cubic foot volume, basal area, and number of trees per acre all were suddenly reduced. The manner in which they have attempted to recuperate is shown by the records of permanent growth study plots compiled in Table 1, page 12.

Rate of recovery depends largely on such factors as site, remaining species, age of stand, density of stocking, and former abundance of chestnut. Forests consisting of 5 to 40 per cent chestnut have recovered largely to their former status within ten years after its elimination. However, only where chestnut was less than 10 per cent of the original stand is the total volume greater today than in 1916. Where it made up 40 to 60 per cent of the stumpage the present volume still shows a deficiency of 5 to 35 per cent, based on stands of middle age and older. As evidenced by plot 1, Table 1, younger timber, especially if favorably located, may have been able to recover from an even greater reduction of wood volume. However, the growth maintained by this plot is exceptional and is largely accounted for by the excellent site on which it occurs, together with the fact that such rapid-growing trees as black locust, red maple, and red oak comprise a major portion of the growing stock. In most instances the process of reconstruction was slow on account of the presence

of intermediate and suppressed trees. When released from overhead shade, it required some time for such trees to adapt themselves to the changed conditions of environment and to respond with an adequate acceleration of growth. Also, because of the slow growth rate of rock oak and its frequent inability to recover from suppression, vast mountainous areas over which this species now predominates have not only suffered, but probably will continue to show, a tremendous loss of increment.

Then too, wherever chestnut was abundant, in stands largely of coppice origin, there will be a loss of growth for a time, due to the predominance of seedlings in the next rotation (33). To transform such areas to a high forest of slower-growing seedling trees cannot result otherwise than to bring about some reduction of increment. There are outstanding benefits, however, that more than compensate for this and make such alteration in character of the growing stock altogether desirable.

In predicting the future growth of forests, we must, however, give consideration to the many small trees, now developing in chestnut openings, soon to enter the measurable size class; in time they will make a substantial contribution to the present growing stock. But, regardless of other factors, the present growth rate of from 30 to 50 cubic feet per acre per year for the poorer sites is very meager, when it is known that some conifers, if located on the same areas, would grow much faster. When faced with the likelihood of a still further reduction in growth, after the period of acceleration has passed, it is evident that foresters and timberland owners are justified in considering supplemental planting or even artificial conversion of slow-growing hardwood forests to mixed forests containing faster-growing conifers. This is particularly true of large areas of impoverished mountain soils where most hardwoods grow too slowly to yield profitable forest crops.

NATURAL REPLACEMENT OF CHESTNUT IN THE MONT ALTO STATE FOREST

The Mont Alto State Forest is located in the extreme south-central part of the State, in the South Mountains of Franklin and Adams Counties. The woodlands were owned by the Mont Alto Iron Company from 1807 to 1892, during which period they were cut-over repeatedly for production of charcoal. Consequently, the present stand of timber is largely of sprout origin and averages from 35 to 50 years of age. Before entrance of the blight there were present about 8.6 cords of thrifty growing trees per acre, of which amount 40 per cent was chestnut (34). The 23,000 acres contained within this State Forest serve the purpose of study and demonstration for the Pennsylvania Forest Research Institute. It was for this reason, and also because the Mont Alto Forest is typical of the extensive oak-chestnut type throughout central and southern Pennsylvania, that the study of chestnut replacement here was initiated and followed intensively.

Subsequent field studies, conducted in other parts of the State, revealed the fact that chestnut replacement conditions throughout Pennsylvania varied little in essential details from those existing in the Mont Alto and the neighboring Michaux State Forests. The greatest difference was noted in the transition zone between the oak-chestnut-hard pine and the beech-birch-maple forest types, and wherever chestnut occurred as scattered individuals throughout the latter. Accordingly, the plan of procedure adopted was to focus particular attention on the chestnut replacement situation as it was found to exist in the Mont Alto Forest and then to emphasize whatever important differences were noticed elsewhere in the State.

Species Replacing Chestnut

The species replacing chestnut comprise those that formerly were most closely associated with it. Common companion trees of chestnut, in the Mont Alto State Forest, are the oaks—rock, white, black, scarlet and red oak—red maple, black locust,

sassafras, black gum, Juneberry, pignut hickory, and black birch. Additional species occurring on better sites, such as coves, lower slopes and fertile benches, include tulip poplar, hemlock, white pine, and white ash. Pitch pine and table mountain pine frequently grow with it at higher elevations.

From the standpoint of present market conditions it is evident that not all these species could be considered equally desirable. Some yield valuable forest products, but others are inferior trees and of little commercial importance. Accordingly, to secure a practical perspective of changed forest conditions, the trees taking the place of chestnut were arbitrarily divided into two groups: (1) more desirable, and (2) less desirable replacement species. Those considered as being less desirable are red maple, sassafras, black gum, Juneberry, black birch, and wild black cherry, all of which are more or less weed species within the oak-chestnut type, although birch and especially cherry are valuable trees in the northern hardwood type. The other species mentioned were classed as more desirable for future forest management.

Some species, not of present economic value, do possess characteristics that would appear to make them silviculturally desirable. For instance, their leaf litter may decompose readily, thus hastening the formation of humus and improving soil fertility, or it may be assumed that their subordinate position in the crown canopy assists in bringing about a more complete utilization of the site. At the same time it must not be overlooked that they also possess growth habits detrimental to the establishment of more valuable species. Invariably they take immediate possession of any forest opening created by the removal of overhead shade. In practically every instance they are short-lived trees, very susceptible to heart rot, and consequently yield material of small size and inferior quality, useful for little else than cordwood. It is believed that the future silvicultural policy for Pennsylvania will show an ever-increasing tendency to stress quality of wood materials produced. This is particularly true of State Forests, in which long rotations, resulting in high-grade materials, certainly are justified.

Some replacement species are capable of yielding products that will serve as satisfactory substitutes for chestnut. For fence posts black locust is much superior to chestnut, but extensive demands have so diminished the supply that it is becoming increasingly difficult to obtain. As a rough construction lumber, hemlock and such hard pines as pitch, table mountain and scrub pine, should prove almost equally serviceable. These same species are employed to a considerable extent for mine props, mine ties, lagging, and other uses to which chestnut lent itself in both the hard and soft coal regions of Pennsylvania. All the oaks possess a grain very similar to chestnut and for that reason are well adapted to replace it for furniture and interior work. In the manufacture of boxes, crates and packing cases the poorer grades of white pine, tulip poplar, and other light woods such as basswood, hemlock and pitch pine will readily substitute for chestnut. There is one important product of chestnut, however, that none of the replacement species are able to furnish, namely, telephone and telegraph poles. For this latter use its closest competitors are northern and southern white cedar, western red cedar, southern yellow pine and Douglas fir (17).

Advance Growth of Replacement Species

When the chestnut was yet alive and thrifty, many trees of other species were growing in the shade of its canopy. The term "advance growth" embraces all those individuals formerly existing as an understory beneath the chestnut. For the most part they were intermediate and suppressed trees. As the chestnut died from effects of the blight it gradually released them from the suppression of overhead shade. Where advance growth is present on chestnut-depleted areas it stands in position to fulfill the work of replacement for the immediate future. A summary of all field

TABLE 2. ADVANCE GROWTH¹ OF REPLACEMENT SPECIES RELEASED BY DEATH OF THE CHESTNUT
MONT ALTO STATE FOREST, FRANKLIN COUNTY
(Based on the Study of 1618 Chestnut Openings²)

SPECIES	COVE		LOWER SLOPE		MIDDLE SLOPE		UPPER SLOPE		RIDGE		AVERAGE FOR ALL SITES	
	Relative Abundance (%)	Average Dis-tribution (%) ³	Relative Abundance (%)	Average Dis-tribution (%) ³	Relative Abundance (%)	Average Dis-tribution (%) ³	Relative Abundance (%)	Average Dis-tribution (%) ³	Relative Abundance (%)	Average Dis-tribution (%) ³	Relative Abundance (%)	Average Dis-tribution (%) ³
MORE DESIRABLE REPLACEMENT SPECIES												
Red Oak	5.6	13.8	5.1	13.6	4.7	12.4	2.3	5.4	2.8	7.1	4.2	10.5
White Oak	7.7	19.0	16.0	42.2	2.3	6.0	0.4	0.9	---	---	5.4	13.6
Black Oak	0.6	1.6	6.8	18.0	6.1	13.6	8.0	18.3	3.4	8.8	5.6	14.0
Scarlet Oak	2.7	6.7	10.9	28.9	11.7	30.6	8.2	20.1	10.5	---	9.3	20.3
Rock Oak	14.4	35.2	17.7	46.9	26.3	69.1	33.2	76.1	28.0	---	24.5	62.0
Total for Oaks	31.0	15.3	56.5	29.9	51.1	26.3	52.7	24.2	44.7	29.5	49.0	24.1
Black Locust	2.9	7.1	7.1	7.1	7.0	18.4	7.2	16.4	9.8	25.4	5.8	14.5
Pignut Hickory	2.1	5.1	5.1	13.6	3.8	10.0	4.4	10.1	4.9	12.7	4.1	10.3
Tulip Poplar	7.3	17.8	0.6	1.5	---	---	---	---	---	---	1.2	3.1
Yellow Birch	1.0	2.4	---	---	---	---	---	---	---	---	0.1	0.4
White Ash	0.2	0.4	0.1	0.3	---	---	---	---	---	---	0.1	0.1
Hemlock	4.7	11.4	0.2	0.6	---	---	---	---	---	---	0.8	1.9
White Pine	0.3	0.8	1.7	4.4	0.1	0.2	---	---	---	---	0.4	1.1
Pitch Pine	---	---	0.7	1.8	1.1	2.9	5.2	7.3	3.9	10.0	1.6	4.1
Table Mtn. Pine	---	---	---	---	---	---	---	---	0.1	0.6	0.1	0.1
Total for Desirable Species	49.5	10.1	67.6	14.9	63.1	18.1	67.5	19.3	63.4	19.6	63.2	11.1
LESS DESIRABLE REPLACEMENT SPECIES												
Red Maple	25.2	61.7	17.4	46.0	16.0	42.1	13.7	31.4	17.1	44.2	17.3	43.4
Sassafras	2.7	6.7	2.6	6.8	10.6	27.8	8.2	18.7	9.4	24.3	6.9	17.3
Black Gum	7.9	19.4	7.5	19.8	8.9	23.4	6.6	15.2	5.6	14.4	7.5	18.9
Junecberry	2.6	6.3	0.7	1.8	0.1	0.2	0.7	1.6	0.4	1.1	0.8	2.0
Black Birch	11.8	28.9	2.7	7.1	0.5	1.2	1.4	3.3	0.1	0.6	2.9	7.2
Wild Bl. Cherry ⁴	0.3	0.8	0.1	0.3	---	---	0.3	0.7	0.9	2.2	0.2	0.6
Large-toothed Aspen	---	---	1.0	2.7	0.3	0.7	0.8	1.9	2.2	5.5	0.7	1.9
Flowering Dogwood	---	---	0.4	1.2	0.5	1.4	0.8	1.9	0.9	2.2	0.5	1.4
Total for Less Desirable Species	50.5	20.6	32.4	10.7	36.9	13.8	32.5	9.3	36.6	11.8	36.8	11.6
Total All Species	100.0	13.6	100.0	13.2	100.0	16.3	100.0	14.3	100.0	15.5	100.0	11.3
Number of Chestnut Openings Studied	620		339		418		427		181		1618	

¹ The term "Advance Growth" refers to trees which were formerly growing as an understory beneath the chestnut. As the chestnut died from the effects of the blight they were gradually released from the suppression of overhead shade. Wherever advance growth of other species is present on chestnut areas it stands in position to fulfill the work of replacement for the immediate future.

² Chestnut openings are the blank spaces left in the forest after the death of the chestnut.

³ If advance growth of a species is present in all of the 620 chestnut openings studied for Cove sites it is given a distribution of 100%, if in 510 its distribution is 50%, etc., and likewise for other sites.

⁴ Wild black cherry seldom makes a desirable forest tree within the oak-chestnut type in Pennsylvania.

studies, covering advance growth of replacement species in the Mont Alto State Forest, is presented in Table 2, page 16.

It will be noticed that approximately half of the advance growth consists of oak, with rock oak in the leading role. In fact, on all sites excepting coves, where red maple assumes dominance, rock oak outnumbers all other species, red maple standing second in abundance. For cove sites, the leading species, in their relative order of abundance, are red maple, rock oak, black birch, black gum, white oak, tulip poplar, red oak and hemlock, with all others combined making up about 15 per cent of the advance growth present. On lower slopes the oaks are prominent, the order changing to rock oak, red maple, white oak, scarlet oak, black gum, black oak, red oak, and pignut hickory, the remaining 15 per cent being divided among 12 other species. At higher elevations—middle slope, upper slope, and ridge—much the same situation exists, except that white and red oak decrease in abundance, their respective places being taken over by black locust, sassafras, and pitch pine. As an average for all sites in the Mont Alto Forest, the ten leading species showing most prominence in the advance growth are as follows: rock oak 25.5 per cent; red maple 17.3 per cent; scarlet oak 9.3 per cent; black gum 7.5 per cent; sassafras 6.9 per cent; black locust 5.8 per cent; black oak 5.6 per cent; white oak 5.4 per cent; red oak 4.2 per cent; and pignut hickory 4.1 per cent. These ten species comprise 90 per cent of the total, the other 10 per cent being divided, in relative order, among black birch, pitch pine, tulip poplar, hemlock, Juneberry, large-toothed aspen, flowering dogwood, white pine, wild black cherry, yellow birch, white ash, and table mountain pine.

As we ascend the slopes, from cove to ridge, the advance growth of certain species increases, whereas that of others shows a gradual decrease in abundance. This tendency reflects largely the silvical requirements of different species for a proper adjustment of soil, moisture, light and other factors essential to their best growth and development. Thus, as elevation increases, rock oak, black locust, pignut hickory, pitch pine and flowering dogwood gradually become more common, whereas red oak, red maple, Juneberry and black birch steadily diminish. Incidentally, all the above trees, and several others for which the data in Table 2 do not reveal such regularity, are able to endure wide extremes of moisture, temperature, and other site factors. Other trees show a decided preference of habitat; for instance, tulip poplar, yellow birch, white ash and hemlock seldom occur on any but the best sites in the Mont Alto Forest, whereas advance growth of white oak and white pine is most conspicuous on lower slopes with good drainage. Scarlet oak, sassafras and black gum reach their culmination under middle slope conditions, black oak and rock oak on upper slopes, and black locust and pitch pine on the ridges.

We wish to direct attention next to the relative proportion of more and less desirable replacement species represented in the advance growth now present on chestnut areas. On cove sites they are about equally divided, but it is encouraging to note that elsewhere two-thirds of the advance growth consists of more desirable kinds of trees. It is noteworthy that in every situation red maple makes up almost half of the less desirables. This fact is readily explained when it is considered that red maple could well tolerate the dense shade of chestnut. On the other hand, many other trees classed as less desirable are distinctly unable to withstand excessive shade. It is for that reason alone, and not for lack of aggressiveness, that they were forced to assume a minor role from the standpoint of advance growth now present in chestnut openings. As will be shown later, these same species, after death of the chestnut, are well represented in the reproduction that has appeared within the last decade.

There are certain conclusions believed justified from this study of advance growth in the Mont Alto State Forest. In general, it may be said that even where chestnut made up half the forest there are now sufficient trees, of those that formerly grew beneath it, to compose a new stand of satisfactory density. Only on the poorest

sites were they found inadequate to restock the depleted areas. A major portion of the next cut on this forest will consist of the more desirable species. It must be remembered, however, that all advance growth in chestnut openings is much smaller than are the trees composing the dominant crown canopy. In some instances, particularly where chestnut was abundant, this will delay cutting operations until much of the present advance growth becomes of merchantable size. On the other hand, a considerable portion of this advance growth which now dominates the chestnut openings consists of trees that formerly were suppressed and poorly-formed, and now again they are being gradually over-topped by surrounding crowns, and hence capable only of poor growth, yet sufficient to suppress reproduction of better species underneath.

In some ways, the wrecking of what formerly were uniform, even-aged stands of sprout origin may have had compensating advantages. Approved methods of forestry practice, where conditions permit intensive management, are striving more and more toward the production of uneven-aged forests, preferably of mixed species. It may be said that the disappearance of chestnut has changed completely the attitude of foresters toward stands of coppice origin. The tendency now is to employ every available means to encourage the development of seedlings rather than to depend entirely upon sprout reproduction. Considering that the elimination of chestnut, wherever it was an important element, has resulted in at least a two-storied forest, of irregular character, and that seedling regeneration has been noticeably stimulated, we may infer that the results accruing from its loss have not been entirely unsatisfactory.

Reproduction Appearing Since Death of the Chestnut

Not all our attention should be focused on the character and composition of the present forests, some of which even now are of merchantable size. To grow a crop of trees to maturity requires many years. While one stand of timber is maturing other generations of trees are becoming established beneath its canopy. The forester cannot afford to ignore those countless numbers of small seedlings and sprouts that are destined to become the succeeding stand.

It was with this thought in mind that considerable field work was devoted to a study of the reproduction appearing since loss of the chestnut. The natural thinning which occurred could hardly result otherwise than to encourage the establishment and growth of seedlings and sprouts of other trees within the openings vacated by chestnut. Furthermore, the composition of this young growth in chestnut openings is a criterion of reproduction to be expected when we open up timber of this type, either by cutting or fire. The results of this study for the Mont Alto State Forest, based on 60 reproduction plots, are summarized in Table 3, Page 20.

A review of these records shows that large numbers of seedlings and sprouts are now present within the blanks in the forest left by chestnut. On the basis of an acre of chestnut openings there were found to exist from 6,700 to almost 10,000 individuals, far more than can possibly survive. The amount of reproduction is greatest in the coves, decreasing gradually toward the tops of the ridges. Field studies showed that, besides the advance growth present, the space formerly occupied by an average chestnut clump now supports from 200 to 275 seedlings and sprouts that for the most part have appeared within the last decade. About 90 per cent of this new growth consists of seedlings and seedling-sprouts. Such abundant reproduction is indeed encouraging for it shows that natural replacement has progressed more rapidly and already is more complete than previously was anticipated (14). On the other hand, it is evident that in many instances much of the more desirable young seedlings and sprouts will be held back by advance growth and by the closing of the dominant crown canopy.

As was found to be true for advance growth, so also about half of the new growth of young trees consists of oak. The amount of oak increases from 25 per cent in the coves to a maximum of 54 per cent on upper slopes, showing an average for all sites of 40 per cent. Again rock oak assumes the leading role in every situation except coves and lower slopes where red maple outnumbers other competitors. In fact, these two trees make up almost half of the total reproduction recorded on 60 plots, besides showing a greater distribution than any other of the 20 species listed therein. This abundance of oak and maple is not at all surprising, for on most areas throughout this type in Pennsylvania they are unquestionably the species most frequently associated with chestnut.

The situation, obviously, varies somewhat for different sites. In the coves the leading species, in their relative order of abundance, are red maple, sassafras, rock oak, red oak, hemlock, scarlet oak and chestnut (sprouts and seedling-sprouts), with all other species contributing but 17 per cent of the total reproduction. On lower slopes the leading trees are much the same, with but one important exception—hemlock is reduced to a minor position. For middle and upper slope conditions the order changes to rock oak, sassafras, red maple, black gum, chestnut and scarlet oak, the remaining 11 or 12 per cent being divided among 13 other species. The situation is but little different on the ridges, except that red oak and wild black cherry become more prominent, resulting in their taking over the respective places of scarlet oak and black gum. As an average for all sites, the ten kinds of trees showing most prominence in the reproduction are as follows: rock oak 25.1 per cent; red maple 20.1 per cent; sassafras 18.0 per cent; chestnut 8.7 per cent; red oak 5.6 per cent; scarlet oak 5.6 per cent; black gum 4.2 per cent; black oak 2.4 per cent; Juneberry 2.0 per cent; and black birch 1.5 per cent. These ten species comprise 93 per cent of the total, the other seven per cent being divided, in relative order, among hemlock, pignut hickory, wild black cherry, white oak, white pine, black locust, tulip poplar, pitch pine and table mountain pine.

Not until we direct attention to the potential character of the new reproduction is the real crux of the situation revealed. It matters little how abundant are the seedlings and sprouts now replacing chestnut if at maturity the forest has decreased in economic value. Field studies show that this is precisely what is happening, for it was found that about half of the reproduction must be classed as less desirable, while much that is suitable, since it consists largely of intolerant species, will be held back and suppressed, unless released from the overhead shade of both advance growth and dominant trees of the remaining stand. Unfortunately, this holds true almost everywhere in the Mont Alto Forest. The data would seem to indicate that the most serious situation exists in the coves; there 60 per cent of the young growth consists of less valuable trees, two-thirds of which is red maple. However, the vacancies existing in such places are relatively less extensive, for chestnut was not so common in the coves. Then, too, excepting red maple, the companion species there are for the most part more desirable. Although weed trees are not so abundant on slopes and ridges, even there the proportion of valuable species can be considered quite unsatisfactory. On these latter sites, where the forest is more open in character, inferior trees, such as sassafras and black gum, become prominent. It is where the heaviest stands of chestnut occurred that the presence of weed species now offers a serious obstacle to the progress of a rapid natural replacement of desirable character. Similar results were recorded by Retan (28) on this same forest, even while the chestnut was yet living. His data show that prior to 1918 weed species made up practically half of the young replacement growth that was appearing as the chestnut was dying. Other investigators (17, 29) found a somewhat analogous situation in New Jersey.

TABLE 3. SPECIES, AMOUNT, AND HEIGHT GROWTH OF REPRODUCTION IN 1930 WHICH HAS APPEARED IN THE CHESTNUT OPENINGS SINCE THE DEATH OF THE CHESTNUT (1915-1920)

Mont Alto State Forest, Franklin County, Average For All Sites¹ (Based on 60 Plots²)

Species	AMOUNT OF REPRODUCTION ³				HEIGHT GROWTH OF REPRODUCTION ⁴			
	Number Per Chestnut Opening ³	Number Per Acre ⁴	Per Cent Of Total (%)	Distribution Of Species (%) ⁵	Over 3 Feet In Height (%) ⁷	Over 6 Feet In Height (%) ⁸	Average Height Of 3 Tallest Saplings on Each Plot (Feet)	Average Height Of All Reproduction Present (Feet)
Red Oak	13	464	5.6	76.7	3.0	2.3	3.1	1.1
White Oak	2	71	0.9	28.3	1.3	0.9	2.6	1.6
Black Oak	6	197	2.4	53.3	2.0	1.1	2.6	1.3
Scarlet Oak	13	461	5.6	71.7	4.1	1.8	2.9	1.1
Rock Oak	59	2078	25.1	98.3	16.4	13.3	5.2	1.3
Total for Oaks	93	3271	39.6	65.7	(Av.) 26.8	19.4	3.3	1.2
Black Locust	1	46	0.55	26.7	1.3	1.4	4.2	3.0
Pignut Hickory	3	120	1.4	45.0	3.4	4.1	4.6	2.7
Tulip Poplar	1	43	0.4	13.3	1.2	1.9	6.8	3.6
Hemlock	4	125	1.5	21.7	1.2	1.4	3.4	2.4
White Pine	2	52	0.6	23.3	1.0	0.4	2.2	1.7
Pitch Pine	0.5	2	0.02	5.0	---	---	0.6	0.6
Table Mountain Pine	0.5	3	0.03	2.0	---	---	0.6	0.6
Chestnut	21	721	8.7	95.0	21.9	13.9	5.9	2.7
Total for Desirable Species	126	4383	52.8	22.9	(Av.) 56.8	42.5	3.4	1.6
Red Maple	47	1660	20.1	93.3	26.3	36.4	7.7	2.2
Sassafras	43	1491	18.0	91.7	2.8	2.4	2.6	1.1
Black Gum	10	349	4.2	75.0	9.8	14.2	5.7	2.6
Juneberry	5	169	2.0	63.3	1.9	2.5	3.3	1.6
Black Birch	3	124	1.5	26.7	2.1	1.6	3.4	2.0
Wild Black Cherry ⁹	3	113	1.4	23.3	0.3	0.4	1.5	0.5
Total for Less Desirable Species	111	3906	47.2	62.2	(Av.) 43.2	57.5	4.0	1.8
Total For All Species	237	8289	100.0	35.3	(Av.) 100.0	100.0	3.6	1.7

¹ Includes 24 sites with a northern aspect, 16 with a southern, 12 eastern, and 8 western; all characterized by a sandy clay loam soil.

² Using a clump of dead chestnut as a center, circular plots were laid out with a 20 ft. radius. Large enough chestnut openings were selected so that no measurements were taken outside the boundaries of the natural opening in the crown canopy.

³ Chestnut openings were taken outside the blank spaces left in the forest after the death of clumps of chestnut sprouts. Each clump of sprouts caused an opening.

⁴ The term "Per Acre" means an acre of chestnut openings. The number per acre is 35 times the number per chestnut opening.

⁵ If a species was present on all of the 60 study plots, it was given a distribution of 100%, if on 30 plots 50%, etc.

⁶ Included in the reproduction are seedlings, seedling-sprouts, and stump-sprouts, varying in age from 1 to 15 years.

⁷ The total number of saplings over 3 feet in height is 12.1% of all reproduction present on the 60 plots. The 12.1% is divided as follows:—Oaks 3.3%, other desirable species 3.6%, less desirable species 5.2%.

⁸ The total number of saplings over 6 feet in height is 5.6% of all reproduction present on the 60 plots. The 5.6% is divided as follows:—Oaks 1.1%, other desirable species 1.3%, less desirable species 3.2%.

⁹ Wild black cherry seldom makes a desirable forest tree within the oak-chestnut type in Pennsylvania.

Height Growth of Reproduction

It cannot be assumed either that the more desirable species eventually will suppress the worthless kinds. To the contrary, there is every indication that the inferior trees can more than hold their own in the race for supremacy.

Ordinarily the tallest seedlings and sprouts that have appeared in the chestnut openings are not of preferred kinds. In all situations, a cross-section analysis of the reproduction shows, for different successive height levels above the ground, a steady decrease of the more desirable trees, with a corresponding increase of those less desirable. Thus, for average conditions, the percentage of desirable species over three feet in height is 56.8, whereas it drops to 42.5 for those exceeding six feet. After selecting the three tallest individuals of every species represented on each of 60 study plots, it was found that an average height for the more and less desirable groups compared as 3.5 to 4.8 feet respectively in the coves, 2.1 to 4.8 feet on middle slopes, 2.5 to 3.8 feet on the ridges, and 3.4 to 4.0 feet as an average for all sites. Such sharp contrast would not be possible if it were based on an average height for all individuals, since this figure shows but little difference to exist between superior and inferior groups, with the latter having some slight advantage. This is accounted for largely by the fact that four-fifths of the new growth appearing since death of the chestnut is now less than three feet tall, while about half of it ranges below a foot.

Closer analysis of the growth data presented in Table 3 will reveal many interesting deductions regarding the behavior of different kinds of trees. This information is useful when it comes to making a comprehensive plan of management for the oak-chestnut type in Pennsylvania. In the present discussion only a few of the more salient facts disclosed by the study will be brought to the reader's attention.

It will be noticed that the oaks, although seeding abundantly into chestnut openings, are nevertheless losing ground to other faster-growing trees. Whereas they constitute 40 per cent of the total reproduction, only 27 per cent is over three feet in height and still less, about 19 per cent, reaches above six feet. This would suggest the advisability of undertaking release cuttings and weeding in the new growth to increase the proportion of oak and other valuable species in the next rotation.

Most of the other species competing with the oaks show a progressive increase among the taller height classes. It is noteworthy that, in advancing from the three-foot to six-foot height level, red maple increases in abundance from 26 to 30 per cent on cove, lower slope and middle slope sites, 40 to 80 per cent on upper slopes and ridges, and with an average increase for all sites of approximately 38 per cent. This rapid height growth of red maple is particularly significant when it is considered that it out-numbers all other competitors which have attained a height of three feet or greater since death of the chestnut. The only other trees showing a larger increase than red maple, when progressing from the three-foot to six-foot height level, are tulip poplar and black gum; of these, tulip is practically limited to coves and lower slopes. Many of the undesirable features of red maple are likewise possessed by such other trees as black gum, sassafras, Juneberry, black birch and wild black cherry. To eradicate or even to control them, now that they are firmly established, is a problem deserving of the best thought and effort of all foresters in Pennsylvania.

Shrubby and Herbaceous Plants

Shrubs and herbs also have gained a foothold in the forest openings left by chestnut. Attention was given to these lesser plants, for their presence often hinders or prevents the establishment of potential timber species. Most numerous, on the Mont Alto Forest, are the blueberries and huckleberries, mountain laurel, scrub oak,

green brier, maple-leaf viburnum, witch hazel, sweet fern, beaked hazelnut, and purple azalea of the shrubby plants, and wild yamroot, teaberry, sarsaparilla, spotted wintergreen, Solomon's seal, chicken grape, tick trefoil, Virginia creeper and bracken fern among the herbaceous plants. With but few exceptions, the situation elsewhere in the State is practically the same.

Our study reveals that wherever chestnut was abundant it left the woods so open in character that many intolerant shrubs and herbs could gain entrance. A large proportion of the species listed rarely occur where the forest cover is complete. Usually they frequent areas recently burned or cut-over, natural forest openings, along roads and trails or woodland borders. Where chestnut was a minor component of the stand the surrounding trees quickly expanded their crowns into the gaps in the forest canopy and thus discouraged the growth of many shrubs and herbs. The principal objection to their presence is that they delay the progress of natural succession to normal forest conditions. Tree species, when once established, will soon overtop and partially or completely suppress these undesirable forest weeds.

Also, it is logical to assume that the elimination of chestnut will cause many calcifugous plants to decrease gradually in abundance (26). Both observations and records from reproduction plots appear to substantiate this assumption. Where chestnut formerly occurred in heavy stands it is not uncommon at present to see numerous patches of dead and dying laurel and huckleberry. This fact may be attributed to modified soil conditions, resulting in a more neutral or even alkaline tendency.

Other Factors Affecting the Present Situation

It should not be assumed that this abundance of inferior trees and shrubs can be attributed directly to loss of the chestnut, although such severe natural thinning undoubtedly did exert a profound influence on the character of the replacement growth. But the real crux of the situation had its origin long before the appearance of the blight. The latter only served to aggravate further what already was apparent for decades previously, namely, the gradual ascendancy of undesirable shrub-weed species in our second-growth forests. Ever since the removal of Pennsylvania's original forest heritage, subsequent conditions have reacted unfavorably for successful re-establishment of the more valuable timber trees that once were so common.

It has long been recognized that repeated clear cutting and fire constitute the two agencies most responsible for forest deterioration. Even-aged stands of sprout hardwoods, showing plainly the harmful effects of both fire and axe, characterize most of the wooded areas of this State and bear testimony to their past treatment. A major portion of our forests included within the oak-chestnut type have been worked and re-worked as new products entered the market. Exhaustive cuttings undoubtedly brought about a considerable reduction of the better trees, with the result that the present stands of timber represent largely the culled remnants of former very fine hardwood forests. Then, too, much of this sprout hardwood region has been clear-cut many times for the production of charcoal. After each cutting it was not unusual for slash fires to occur. This process of forest destruction continued unhampered until about 1902, when forestry and forest protection began to acquire support in Pennsylvania. If it were not for the unusual recuperative power that characterizes forests of this type, such injurious treatment would long since have resulted in even more serious deterioration.

Unfortunately, as evinced throughout biological phenomena, the less desirable forms of life usually are the most difficult to suppress. Nor does the situation differ materially with respect to forest trees, for those suited for little else than cordwood seed abundantly, sprout profusely, make rapid juvenile growth, and possess other attributes that insure their survival, despite hardships which the better

species often are unable to surmount. Consequently, each fire and clearcutting to which the forest is subjected tends to increase the number of non-timber trees in the succeeding stand. In case of successive forest fires on the same area, extending over a long period of years, there often results a complete change in character of the existing forest type (5). That this destructive treatment gradually eliminates the better trees, thereby forcing a regression to worthless brush land, is well exemplified by the scrub oak barrens so common in various portions of Pennsylvania. Although these areas represent extreme abuse, there is little question but that the forests of this State have been deteriorating ever since the original timber was exploited, caused almost entirely by factors other than destruction of the chestnut.

NATURAL REPLACEMENT ELSEWHERE IN PENNSYLVANIA

Field studies revealed that the progress of chestnut replacement throughout Pennsylvania varies little in essential features from that which has been shown to exist in the Mont Alto State Forest. A summary of the situation in various portions of the State is shown in Table 4, page 24. Some slight variation, as revealed by the data, undoubtedly is caused by differences in natural distribution of the tree species concerned. The following paragraphs will be devoted to a discussion of certain details of chestnut replacement that were found to differ somewhat in various portions of the State.

Central Pennsylvania

(Franklin, Fulton, Adams, Huntingdon, Blair, Centre, Union, Snyder, Mifflin, Juniata, Perry and Cumberland Counties)

Throughout this entire section of the State chestnut occurred in heavy stands and probably attained its optimum development. No other region shows a more striking similarity to conditions existing in the Mont Alto State Forest. What actual differences do exist are of minor significance. The data reveal that red oak, white oak, hemlock, white pine, black birch, white ash and flowering dogwood are slightly more abundant than in the Mont Alto Forest, whereas sassafras and black gum show less prominence. Other trees, of rare or local occurrence in the extreme south-central counties, here assume a minor role in filling the blanks left by chestnut. These are scrub pine, bitternut hickory, cucumber, mountain maple, striped maple and hop hornbeam.

In the Michaux State Forest, in Adams County, scarlet oak is a leading replacement species. Further westward, on the steep slopes of Cove and Tuscarora Mountains, Fulton County, a considerable amount of black locust has become established where chestnut formerly was plentiful. In these situations black locust probably never will become larger than tree size, but it enriches the ground and prepares the way for a better crop of trees.

Southwestern Pennsylvania

(Bedford, Somerset, Fayette, Cambria and Westmoreland Counties)

The most outstanding feature of chestnut replacement in these counties lies in the fact that less-desirable species were found to be more prominent than anywhere else in the State. They comprise over half of the advance growth and reproduction. Red oak and red maple are the leading replacement species, followed in order by rock oak, sassafras, wild black cherry, black gum and Juneberry. Fire cherry and mountain ash also were observed in the chestnut openings.

TABLE 4

SUMMARY OF FIELD STUDIES SHOWING ADVANCE GROWTH AND REPRODUCTION OF SPECIES REPLACING CHESTNUT IN PENNSYLVANIA

(Based on Studies Made in 2788 Chestnut Openings in 28 Counties)

All Data Shown In Per Cent (%) Of Total For Each Species

SPECIES	MONT ALTO FOREST ¹		CENTRAL PENNA. ²		S. W. PENNA. ³		N. W. PENNA. ⁴		N. E. PENNA. ⁵		EXTREME N. E. PENNA. ⁶		TRANSITION ZONE ⁷		ENTIRE STATE	
	Adv. Gwth. ⁸	Repr. ⁹	Adv. Gwth.	Repr.	Adv. Gwth.	Repr.	Adv. Gwth.	Repr.	Adv. Gwth.	Repr.	Adv. Gwth.	Repr.	Adv. Gwth.	Repr.	Adv. Gwth.	Repr.
MORE DESIRABLE REPLACEMENT SPECIES																
Red Oak	4.2	5.6	9.3	7.9	17.7	15.0	10.6	11.5	9.2	7.6	4.8	7.1	6.0	9.2	6.6	9.6
White Oak	5.4	0.9	8.2	5.7	3.0	0.7	16.3	11.2	7.7	6.7	15.7	8.2	0.9	0.9	6.4	6.4
Black Oak	5.6	2.4	3.0	5.3	0.7	1.7	2.4	3.9	3.8	2.3	2.0	2.2	---	---	4.2	3.4
Scarlet Oak	9.3	5.6	5.7	4.7	1.6	2.0	0.5	1.3	6.2	10.3	5.0	12.8	---	---	7.0	6.0
Rock Oak	24.5	25.1	22.1	18.6	12.0	10.6	9.1	6.5	21.4	17.7	17.6	13.4	4.1	7.8	21.1	13.5
Total For Oaks	49.0	39.6	48.3	42.2	35.0	36.0	38.9	34.4	48.3	44.5	45.1	44.7	10.1	17.9	45.3	38.9
Black Locust	5.8	0.55	2.6	1.3	5.1	2.0	0.5	0.8	---	---	---	---	1.3	1.3	4.1	1.2
Pignut Hickory	4.1	1.4	3.4	7.6	2.3	2.5	3.4	5.2	7.7	3.6	9.2	4.9	0.9	2.2	3.7	4.6
Tulip Poplar	1.2	0.4	0.8	0.3	---	---	2.9	0.8	0.1	---	---	---	0.9	0.4	0.9	0.4
Hemlock	0.1	1.5	1.9	3.2	---	---	1.0	1.0	0.8	1.0	0.3	0.4	9.5	5.2	1.2	1.6
White Pine	0.1	0.6	5.8	5.6	1.2	0.3	2.9	1.3	2.4	1.7	8.4	3.9	0.3	---	1.8	2.6
Pitch Pine	0.8	0.02	1.3	0.2	0.3	0.6	0.4	0.3	0.3	---	---	---	---	---	1.2	0.1
Yellow Birch	1.6	8.7	0.2	0.2	0.3	1.3	---	---	---	---	---	---	---	---	0.2	0.4
White Ash	0.1	---	0.2	2.0	0.5	---	---	---	---	---	---	---	4.2	10.6	0.3	2.2
Sugar Maple	---	---	---	---	---	---	---	---	---	---	---	---	13.0	15.7	0.7	0.9
Beech	---	---	---	---	---	---	---	---	---	---	---	---	10.9	6.6	0.5	0.4
Basswood	---	---	---	---	---	---	---	---	---	---	---	---	1.3	0.4	0.04	0.02
Miscellaneous ¹⁰	0.4	0.03	0.9	1.4	1.6	2.1	---	4.1	---	---	---	---	0.3	0.9	0.36	1.28
Total For More Desirable Species	63.2	52.8	65.4	64.0	46.3	44.8	50.0	48.2	53.6	50.8	64.1	60.6	52.7	65.1	60.3	54.6

SPECIES	MONT ALTO FOREST ¹		CENTRAL PENNA. ²		S. W. PENNA. ³		N. W. PENNA. ⁴		N. E. PENNA. ⁵		EXTREME N. E. PENNA. ⁶		TRANSITION ZONE ⁷		ENTIRE STATE	
	Adv. Gwth. ⁸	Repr. ⁹	Adv. Gwth.	Repr.	Adv. Gwth.	Repr.	Adv. Gwth.	Repr.	Adv. Gwth.	Repr.	Adv. Gwth.	Repr.	Adv. Gwth.	Repr.	Adv. Gwth.	Repr.
LESS DESIRABLE REPLACEMENT SPECIES																
Red Maple	17.3	20.1	14.9	12.2	26.1	20.4	33.7	18.5	23.3	19.1	25.7	17.5	17.2	16.6	19.3	16.3
Sassafras	6.9	18.0	1.6	3.5	5.1	10.2	1.0	6.5	7.1	15.0	3.1	5.9	1.6	3.0	5.5	8.3
Black Gum	7.5	4.2	1.6	4.0	4.7	5.5	1.4	3.9	1.8	4.3	0.2	0.8	0.3	0.4	5.1	4.4
Junberry	0.8	2.0	1.1	2.0	3.9	6.1	0.5	2.3	0.4	0.3	1.4	2.8	1.3	0.9	1.1	3.3
Black Birch	2.9	1.5	5.3	3.7	4.6	3.0	2.9	1.8	1.8	1.3	2.2	1.4	5.8	6.1	3.3	2.7
Wild Black Cherry	0.2	1.4	0.4	0.5	5.6	7.2	4.8	14.1	0.1	1.7	0.6	4.9	1.9	3.5	0.9	4.3
Large-toothed Aspen	0.7	---	2.2	0.2	---	---	---	---	0.6	---	---	0.2	4.4	---	0.9	0.08
Flowering Dogwood	0.5	---	5.5	7.1	0.2	0.3	---	---	0.3	4.8	2.0	2.4	1.9	2.2	2.5	3.7
Striped Maple	---	---	0.7	0.8	0.2	0.3	---	0.5	0.1	---	---	---	2.0	2.2	0.2	0.3
Hop Hornbeam	---	---	0.5	0.6	0.3	---	1.4	1.3	---	---	---	0.4	1.9	2.2	0.2	0.3
Fire Cherry	---	---	---	---	---	---	0.5	---	---	---	---	---	4.4	---	0.3	0.1
Butternut	---	---	0.2	---	0.2	0.2	1.4	2.1	---	2.7	0.6	---	---	---	0.04	---
Miscellaneous ¹¹	---	---	0.6	1.4	0.2	---	---	---	---	---	---	---	5.1	---	0.36	1.62
Total For Less Desirable Species	36.8	47.2	34.6	36.0	53.7	55.2	50.0	51.8	46.4	49.2	35.9	39.4	47.3	34.9	39.7	45.4
Total for All Species	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
No. of Chestnut Openings Studied	1518	1518	296	296	207	207	87	87	319	319	138	138	123	123	2788	2788

¹ Mont Alto Forest—Franklin and Adams Counties.² Central Penna.—Franklin, Fulton, Adams, Huntingdon, Blair, Centre, Union, Snyder, Mifflin, Juniata, Perry and Cumberland Counties.³ Southwestern Penna.—Bedford, Somerset and Westmoreland Counties.⁴ Northwestern Penna.—Jefferson, Clarion, Clearfield, Elk and Indiana Counties.⁵ Northeastern Penna.—Northumberland, Columbia, Schuylkill, Luzerne and Sullivan Counties.⁶ Extreme Northeastern Penna.—Pike, Monroe and Wayne Counties.⁷ Transition Zone—That portion of the State where the Beech-Birch-Maple and Oak-Chestnut-Hard pine Types Intermix (See map Page 4) Sullivan, Wayne, Clearfield, Jefferson, Elk; Blair and Westmoreland Counties.⁸ The term "Advance Growth" refers to trees which were formerly growing as an understory beneath the chestnut.⁹ The term "Reproduction" refers to seedlings and sprouts which have appeared since the death of the chestnut.¹⁰ Includes table mountain pine, Jersey scrub pine, bitternut hickory and slippery elm.¹¹ Includes mountain maple, scarlet hawthorn, blue beech, black alder, mountain ash, sweet cherry, scrub oak, Hercules club, gray birch and trembling aspen.

Northwestern Pennsylvania

(Jefferson, Clarion, Clearfield, Elk, Forest, Armstrong, and Indiana Counties)

Field studies conducted throughout this region showed the work of replacement to be divided equally between desirable and less desirable species. Red maple far outnumbers other competitors since it accounts for one-third of all advance growth and almost one-fifth of the reproduction. White oak is more abundant here than anywhere else in the State; it stands second to red maple and is followed closely by red oak and rock oak. Not only is wild black cherry more prominent than elsewhere but it also reaches better development and is altogether worthy of being considered a desirable species. Certain trees of uncommon occurrence in the Mont Alto Forest here assume minor importance in the natural replacement of chestnut; these trees include slippery elm, cucumber, hop hornbeam, mountain ash and butternut.

Northeastern Pennsylvania

(Northumberland, Columbia, Schuylkill, Luzerne, Carbon, Montour, Wyoming, and Sullivan Counties)

Here, too, the replacement species are about equally divided with reference to their desirability. But again it is emphasized that this study dealt primarily with areas protected from fire, and hence the data and discussion concern only Nature's unimpeded efforts to close the forest openings left by chestnut. Probably no other section of Pennsylvania contains such extensive tracts which have been burned and cut-over so repeatedly that inferior species now claim possession.

Throughout northeastern Pennsylvania more space has been taken over by the oaks than in any other portion of the State. The five common oaks—rock, white, black, scarlet, and red oak—make up 90 per cent of the more desirable advance growth and reproduction. Flowering dogwood also was found to be more prominent here than elsewhere. It is worth pointing out that scarlet oak and sassafras increased considerably in the reproduction appearing since the loss of chestnut. Otherwise the situation remains little different from that existing west of the Susquehanna River.

Extreme Northeastern Pennsylvania

(Pike, Monroe, and Wayne Counties)

In these three counties the work of replacement has progressed more favorably than within the boundaries of the hard-coal region. Almost two-thirds of the advance growth and reproduction consists of more desirable species. Of the oaks, white and scarlet are but little less abundant than rock, whereas red and black oak fall behind. Two other valuable trees—white pine and white ash—make a very substantial contribution. On some areas gray birch was formerly associated with chestnut.

Transition Zone

(Sullivan, Wayne, Clearfield, Jefferson, Elk, Blair, and Westmoreland Counties)

The term "transition zone" is used to cover that portion of the State where the beech-birch-maple and oak-chestnut-hard pine types intermix (See map, page 4). At its northern extremity the latter type occurs mostly on warm southern and southwestern exposures. Often it is found at higher elevations, such as upper slopes and ridges, with the beech-birch-maple association occupying the intervening coves and lower slopes. In these situations the two types overlap under middle slope conditions, thus forcing both groups of species to struggle for supremacy of

the chestnut openings. However, within the Allegheny Plateau region of northwestern Pennsylvania, the two forest types are thrown together more or less indiscriminately. But even where the Northern Hardwood Forest rules supreme, scattered chestnut will be found (19).

As might be expected, a slightly different picture of chestnut replacement characterizes this transition zone. So far as the character of the new growth is concerned, the better trees make up about the same proportion as elsewhere. It is the relative position of the many species concerned that constitutes an outstanding difference. Here the oaks are of little significance, with only red and rock oak of any prominence. Together they contribute but 10 per cent of the advance growth and 18 per cent of the reproduction. Red and sugar maple and beech, all tolerant species, comprise more than 40 per cent of the total. White ash and hemlock also play a prominent part. Other important trees typical of the region are basswood, cucumber and slippery elm, as well as such undesirables as fire cherry, striped maple and trembling aspen.

ARTIFICIAL REPLACEMENT OF THE CHESTNUT

It is obvious that if left alone much of the forest area within the oak-chestnut type in Pennsylvania will revert naturally to inferior species, which already are firmly established on practically an equal basis with those more desirable. Much of the present forest growth therefore consists of inferior species, or of weakened, poorly-formed trees of the more desirable kinds. The problem which now presents itself is how to improve conditions so that the better trees may be encouraged. It has been shown that inferior species possess such growth habits that it would be almost impossible to eliminate them entirely, nor is it believed that such an undertaking could be economically justified.

Unquestionably the most important and most urgent problem confronting foresters today is the adequate protection of forests from fire. At the same time it is recognized that protection alone will not serve to produce forests of the highest quality products. Nature's methods often are slow and wasteful, and only by the application of silviculture can the largest and best timber be grown at a profit to the owner. Due to present problems of forest fire danger and unsatisfactory markets for low-grade products, intensive silviculture now is possible only in limited, favored areas, but it is essential that foresters begin to experiment with various methods of stand improvement so that they will be able to apply the best treatment to forests when and where better forestry methods are justified.

Forest Improvement Cuttings

Improvement cuttings provide one of the best means of ridding the forest of inferior trees so that a fair start can be made toward a profitable crop of timber. Salvage of the dead chestnut offers an excellent opportunity to remove at the same time all undesirable species, as well as poor specimens of the preferred kinds. If cutting is further combined with a careful weeding of the young advance growth and reproduction, even though this latter undertaking can show no immediate net profit, there will result immeasurable benefit to the forest. Release of the better trees from competition for light and moisture affords them ample room for development, and they soon respond with an acceleration of growth that in quality and quantity more than compensates for the reduced growing stock. If of seed-bearing age, the remaining trees, because of their additional crown expansion, bear heavier crops of seed and thereby tend to increase the proportion of better species in the succeeding rotation. Stand composition also can be influenced by deferring all cutting until arrival of a good seed year for some preferred species represented on the area to be cut-over, when the disturbing of the soil incident to logging will encourage their seedling establishment. To accomplish these results, all cutting should be planned

carefully and carried on with good judgment, supplemented with a thorough knowledge of local conditions. The axe judiciously applied is a tool for building up the forest as well as for cutting it down.

The growth acceleration of individual trees, which was found to have occurred after elimination of the chestnut, should serve as a criterion of the increased growth that might be expected to result from thinnings and improvement cuttings. If undertaken at an age of 30 to 50 years, the material removed is of marketable size, reproduction is encouraged, and volume growth of remaining trees is greatly accelerated. Considering these practical advantages, it may be desirable to wait and thin fairly heavily, at long intervals, rather than to start early in the life of the stand and practice light and frequent thinnings, as is more often advocated. This is particularly true of the more inaccessible forest areas, on which intensive silviculture cannot at present be justified. Frequent, light thinnings are best adapted to the farm woodlot.

Assuming that a fair market exists for any one of such products as poles, ties, mine timbers, posts, or cordwood, the improvement operation should show some cash returns on the money expended. Mixing the dead chestnut with other species at time of cutting facilitates its disposal, whereas alone it may be difficult to find demand for it. This is particularly true of fuelwood, for which many people object to using chestnut. Although for a quick, hot fire, or for kindling, chestnut is one of the best of woods, since it splits easily and burns rapidly, its undesirable features are that it will snap and crackle and throw sparks profusely. Since other species are preferable for fuelwood, chestnut can be sold more readily if oak and hickory are mixed with it. It is believed to be sound economy to market the chestnut, if only at cost of production, rather than to take the loss and risks involved by allowing it to remain in the woods. Even though he be forced to operate at a slight loss, the owner will profit later due to the increased value of his standing timber. Opening up the forest and letting in more sunlight create conditions favorable for the growth and reproduction of light-demanding trees, such as tulip poplar, black locust, hickory, and some of the better species of oak and pine that formerly associated with chestnut. Then, too, favorable conditions are created for increasing the proportion of conifers or any other desired species by subsequent planting. Should the treated area be located along roads, or in other situations frequented by the public, its slightly appearance contributes both an aesthetic and educational value. A clean forest is good fire insurance and tends to prevent loss from insects and disease.

Despite the benefits to be secured from intelligent use of the axe, there are definite limitations imposed upon this solution to the problem of forest improvement. The most serious obstacle that limits its general application is a restricted market at present for the materials removed. In many instances financial success or failure of the operation hinges largely on local demand for cordwood or small-sized products. Where this situation exists, progress must necessarily be slow and confined to the most accessible areas. Fortunately such is not the case in all portions of the State, especially in proximity to agricultural districts, and in the coal regions, as well as in many localities supporting wood-using industries. There the market for wood is far more varied and stable than that which characterizes our mountainous sections, wherein logging and transportation costs constitute other limiting factors. With the bulk of our State Forests located in the more inaccessible regions, it is obvious that many difficulties confront almost any preconceived plan for their general improvement. Such a situation suggests, however, an urgent need for a comprehensive study of the market conditions prevailing in each district. Forestry has long since demonstrated that to grow timber of mature size and good quality at a profit, as a purely business undertaking, is possible only where thinnings and improvement cuttings are practicable.

Forest Planting

The loss of the chestnut presents an opportunity to initiate a reforestation program aimed toward the improvement of Penn's Woods. Where the forest was naturally thinned to such an extent that plenty of overhead light is now available, planted trees have a chance to survive. This applies particularly to areas formerly supporting heavy stands of chestnut and to the poorer sites, such as mountain slopes and ridges, that usually are characterized by rather open stands of timber.

Although little is definitely known regarding the best species to plant on such areas, there is some justification for recommending certain trees as being more likely to prove successful. It is obvious that no species can be adapted to all situations, since each locality has its own specific planting problems. On sites of the poorest quality it is believed that rapid-growing conifers, such as pitch pine, red pine, and possibly Scotch and jack pine, should be planted. Larch, hemlock, Norway spruce and white pine are other desirable species more suited to the better, more moist and cooler areas, with shortleaf pine in southern Pennsylvania. It has been demonstrated that white pine proves more resistant to weevil damage when planted sparsely under partial hardwood shade.

Planting of conifers on adverse sites receives further recommendation in view of the fact that hardwoods, because of their slow growth and inability to attain large size, are ill-adapted there to form a profitable forest crop. To reinforce woodlots and other valuable stands located on good sites it may be more desirable to use native hardwoods, such as tulip poplar, white ash, red oak, sugar maple, black locust, or basswood. In most localities supplemental planting alone should suffice, but there are extensive areas where it may be necessary to resort to artificial conversion in order to replace the present inferior growth with valuable forest trees.

Past experience with reforestation in Pennsylvania largely relates to old field sites formerly under cultivation. The fact that practically all such areas located in State Forests now have been planted explains directly the rapid decline in State Forest planting within recent years. Those plantations, covering some 25,000 acres, not only stimulated public interest in forestry, but also have served as valuable object lessons with reference to the silvical habits and growth requirements of different species of trees. From the many long years of labor required to establish and protect these planted trees there has resulted, among other things learned, this one bit of hard-earned experience; namely, the advisability of maintaining mixed stands of a character similar to those developed under natural forest conditions. Herein lies the advantage of planting conifers on chestnut-depleted areas, not necessarily with the purpose of complete conversion, but rather that the natural growth of hardwoods should serve as fillers for the planted trees, forcing their height growth, shading off their lateral branches, and resulting in a mixed stand of selected final crop trees.

One excellent way to handle such planting is in conjunction with forest improvement operations. It is recommended that only sizable, thrifty, well-rooted stock be planted, carefully spotted in the larger chestnut openings, or in other blank spaces left after cutting or fire (3). Caution is particularly advisable when handling planting stock that is light-demanding. When planting recently clear-cut or burned areas extreme care must be exercised to avoid all stumps and dead standing trees that would be likely to sprout vigorously; otherwise the planted trees stand in danger of being quickly over-topped and suppressed by fast-growing hardwood sprouts, and the cost of release cutting is greatly increased. Experience has indicated that to secure successful establishment on such planting sites requires ordinarily from one to three release cuttings, made at intervals of from two to five years, depending upon conditions. The more desirable of the hardwood sprouts and seedlings that

occupy the intervening spaces should be removed only insofar as they interfere with the growth of planted trees.

Experimental work has proceeded sufficiently to permit a reasonably accurate forecast to be made of the expense of improvement cuttings and reforestation for any particular locality. Rather than to deal in generalities, a specific example will be cited of an operation that combined both of the above features and for which the actual cost data are available. Reference is made to a project initiated in the Mont Alto State Forest during the winter of 1930-31, in a 45-year old stand of timber where chestnut formerly comprised 40 per cent of the wood volume. Associated trees consisted of rock, scarlet and some white oak, pignut hickory, red maple, black gum, sassafras and flowering dogwood. The area represents lower slope conditions adjoining a hard-surfaced road. It first was given an improvement thinning that extended over 11½ acres, removing all dead chestnut, inferior species, and poor specimens of the preferred growing stock. As the cutting progressed it assumed in addition the aspect of a weeding of the advance growth and reproduction, which discriminated against even mountain laurel, as well as all undesirable saplings down to less than an inch in diameter.

There was removed from the area approximately 85 cords of wood, an average of 7½ cords per acre, representing 50 per cent of the volume of standing timber. At a labor rate of 30 cents per hour, the cost of felling averaged \$16.12 per acre or \$2.18 per cord. To skid the material to the road and transport it by truck to the wood yard, about 2½ miles distant, necessitated an additional cost of \$2.72 per cord. Another item of expense included 20 cents per cord for marking the trees to be cut (by a trained forester), making a total removal cost of \$5.10 per cord. Sold locally for fuelwood, the price obtained just about paid for the cost of the operation. When considering the benefits that the improved stand derived, this work undoubtedly will prove a very profitable undertaking.

This same area later was underplanted, using two-year-old seedlings of red, pitch, shortleaf and white pine, also some hemlock. Since the brush had been lopped and scattered well, it presented but little hindrance to the work of planting. Placing the trees in only the larger openings, particularly those that had been left by the chestnut removed, required an average of only 300 seedlings per acre. If properly located this number is sufficient, however, to form at maturity a good mixed stand containing, in addition to conifers, the best of the local hardwoods. Because of the extremely rocky nature of the area and consequent difficulty of securing enough soil with which to cover the roots of planted trees, the planting cost of \$3 per acre was necessarily high. Under these conditions it pays to do the work carefully, since percentage of establishment, the eventual criterion of success, is increased by good rather than by rapid planting. As suggested previously, these trees will need assistance later to release them from hardwood competition. Past experience indicates that, under ordinary conditions, the total cost of periodic release cuttings, throughout the early stages of the rotation, should not exceed \$5 per acre (3).

This operation is cited because it represents one of the few available examples of an attempt at artificial replacement of the blight-killed chestnut. There is every reason to believe that the results will be satisfactory. What is urgently needed is more work of this character to be undertaken in different parts of the State. In some localities planting within the natural openings left by chestnut could be successful without any preliminary improvement of the stand. Ordinarily, however, some cutting would be advisable in order to get the planted trees well established before the overhead canopy closes and before hardwood reproduction can impede their growth. Planting, as a general restorative measure, should not be attempted where the character and amount of natural regeneration insures a satisfactory stand at

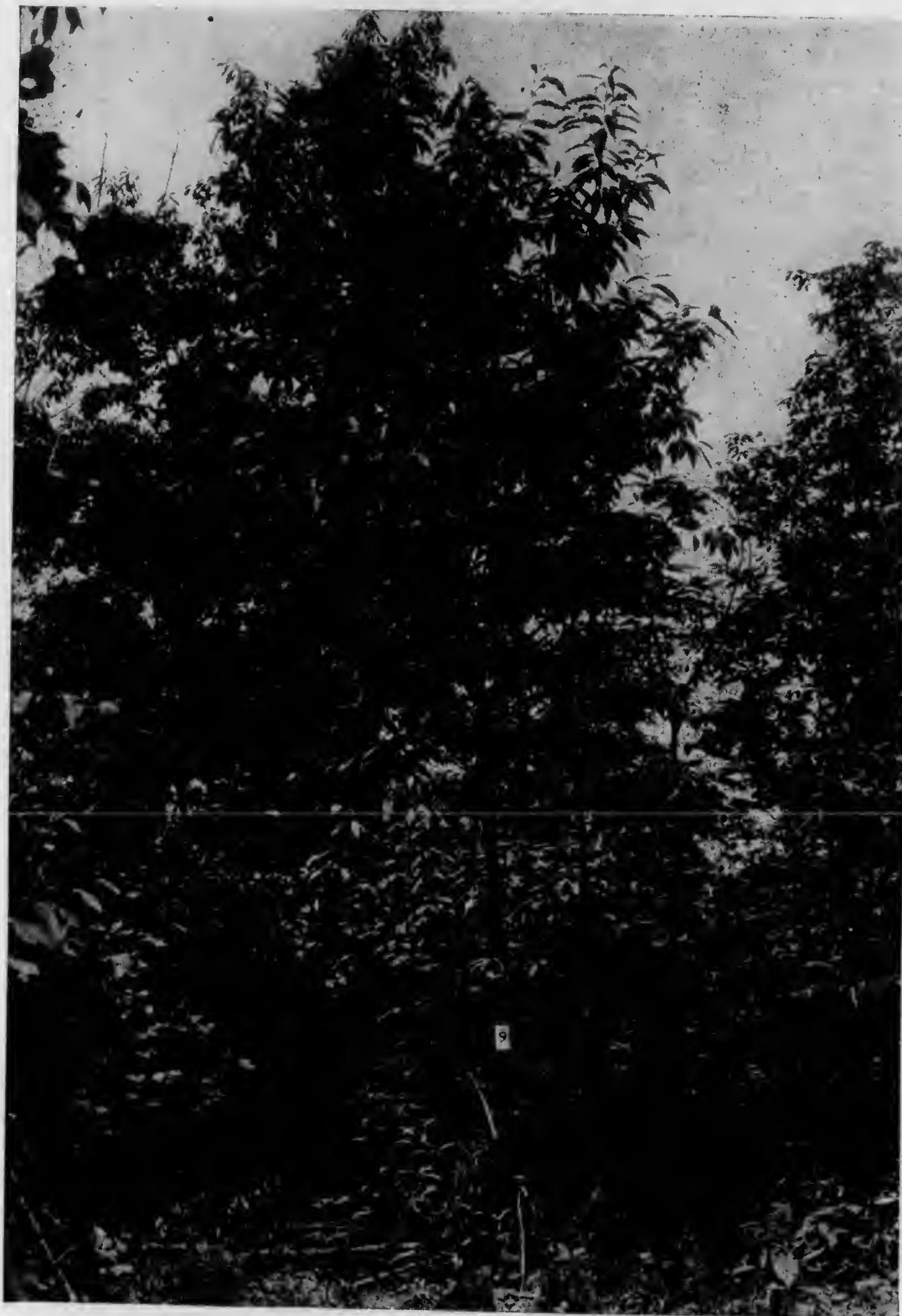
maturity. This is particularly true of the more fertile sites, on which it would be a mistake to introduce conifers if fast-growing hardwoods are present. With millions of acres in need of improvement there is no necessity to waste time and effort where Nature can assure a satisfactory replacement.

It is not anticipated that this stupendous task of rehabilitating vast areas of wrecked and degenerated forest land can be accomplished immediately. What has resulted from a half-century of forest abuse cannot be rectified in a few years of constructive effort. More immediate importance attaches to a thorough realization of the problem at hand, which in turn will suggest a need for action. Salvaging of the dead chestnut, where it still remains standing, presents a practical opportunity to begin the work of placing the forests of Pennsylvania on a sound producing basis.

CHESTNUT MAY YET RECOVER

Thus far our discussion is based on an assumption that the chestnut has been entirely eliminated, resulting in other species taking over its place in the forest. Despite the gloomy outlook which generally has been portrayed for the tree, many foresters and forest pathologists are of the opinion that it is making slow but substantial progress in its struggle with the blight. During the past five years this problem has received close attention and study at the Pennsylvania Forest Research Institute, the preliminary results of which have been published in a recent circular by the Pennsylvania Department of Forests and Waters (2). This is a companion study of the one under discussion, and hence its results have a direct bearing upon the chestnut situation in Pennsylvania. Some of its conclusions arrived at are therefore set forth as follows:

1. The persistent sprouting ability of the chestnut is its main hope. For 20 years it has persistently met its death loss with repeated crops of new sprouts. In some regions as many as eight different generations of sprouts have already appeared. The blight has not yet been able to kill all the root systems from which sprouts develop. These sprouts are the main battleground of the blight.
2. Recent studies indicate that the chestnut shows greatest promise of recovery: (a) on areas where the chestnut was cut before it was completely killed by the blight; (b) where sprouts originated from small stumps or seedling-sprouts; (c) on slopes with a warm southern or southwestern exposure; and (d) where overhead shade is not too dense.
3. Great numbers of chestnut sprouts, three to four inches in diameter, are now growing in the forests. The largest sprout recorded at Mont Alto was five inches in diameter and 35 feet high when 12 years old.
4. Many of the larger sprouts, ranging from 3 to 4 inches in diameter and from 6 to 12 years old, are beginning to bear fully-formed chestnut burs containing a fair percentage of mature nuts. This indicates that the chestnut is resisting the blight, or that the disease is becoming less virulent.
5. More cankers are now required to kill a sprout than in the early days of the blight. It is not uncommon to see a sprout struggling tenaciously with as many as a dozen cankers upon it. In the early days of the blight, a single canker often was sufficient to kill a tree.
6. Marked changes in the general appearance, form and virulence of the blight cankers have been noted. The swollen hypertrophied type of canker is now becoming more common. This type, caused by the tree's efforts to grow new wood and to resist the disease, appears to be less destructive than the round lesion type, which was most common in the earlier years of the blight. Inactive or healed cankers are becoming more numerous. In many sections of Pennsylvania numerous partially-healed cankers can be found.
7. Sites upon which chestnut has been able to develop into the largest and most thrifty sprouts, despite the destructive efforts of the blight, offer the greatest hope for its future development. Only under favorable conditions can the chestnut be expected to work out its salvation. No practical control measures have yet been found, and it appears that Nature unassisted must work out its own method of control.
8. The peak of the chestnut blight has passed too recently to foretell definitely its future developments, but each year gives additional evidence sig-



A PROMISING CHESTNUT SPROUT UNDER OBSERVATION.

This 12-year-old sprout, five inches in diameter at breast height, 28 feet tall, which has borne several crops of burs within recent years, typifies the chestnut's struggle to recover from the blight.

nifying that this destructive disease has passed its climax in Pennsylvania. There is a growing justification for the hope that chestnut eventually may recover much of its lost ground in the forests of this Commonwealth.

Recent Evidence of Progress

Probably the most encouraging feature of the chestnut situation centers in the fact that the young sprouts have begun recently to bear substantial crops of nuts. For the past six years or more chestnut burs have been noticed in different localities within the State. In some places their occurrence has become so widespread as to attract public attention. They have been especially noticeable throughout the eastern, southern and central portions of the State, representing the region of earliest infection, where the new sprouts have attained largest size and vigor. Reports have indicated that many persons were successful in gathering chestnuts, ranging in quantity from a pocket-full to several quarts.

It is surprising to observe the abundance of burs which now are being borne on very young sprouts. Last year the writer gathered more than five quarts of excellent nuts from sprouts which were only seven years old. This particular area had been burned over in 1926 and more than ten per cent of the resulting chestnut sprouts were bearing fruit. The individual sprouts ranged from 10 to 15 feet in height and many of them had from 2 to 20 burs. Also, it was not unusual to find elsewhere older sprouts with many more burs. For example, actual count on one 12-year-old chestnut tree, in the Mont Alto State Forest, Franklin Conty, showed that there were 82 well-formed burs. Another sprout nearby had 45 burs, and counts on several others ranged from 20 to 30 burs.

Another encouraging feature of the chestnut crop for the past several years was the high percentage of well-developed nuts produced. Previously it was often difficult to find burs which were fertile, for many of them showed only a small central cavity filled with undeveloped nuts. Recent experience has been just the reverse, for most of the burs contained not only one but often three nuts, of large size, and with the kernel filled out completely.

The Resulting Situation

This recent effort of the chestnut to produce nuts of normal size and development is hopeful evidence that the tree is making substantial progress in its struggle to evade extermination. It means that henceforth Penn's Woods will be dotted with young chestnut trees of seedling origin. Since trees of seedling and seedling-sprout origin offer greatest resistance to the blight, it is evident that the chestnut now is entering a new era in its fight to overcome its fungous enemy. Then, too, it is entirely possible that the seedlings now being produced may inherit in some measure an increased immunity against the blight.

To reinforce the old stand of chestnut stumps with a scattering of young seedlings is like adding fresh recruits to an army which has been harassed by the enemy. Although chestnut stumps located in favorable situations are showing apparently no decrease in their sprouting capacity, it is probable that they cannot go on indefinitely producing generation after generation of sprouts. In time the reserve energy stored up in their root systems must become exhausted. Despite the fact that the root systems of stumps are partially extended when sprouts of large size are produced, unless in some way they are materially rejuvenated they must eventually succumb. Thus the new, healthy root system of the seedling chestnut is its most valuable feature. The production of thousands of such new root systems prolongs indefinitely the ability of the species to match its death loss with repeated crops of new sprouts.

There are many angles of practical significance from which the present chestnut situation can be analyzed. On favorable areas it certainly is desirable to permit the



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tree to work out its own salvation. This can best be accomplished by leaving untouched the more thrifty sprouts and in particular those which are bearing burs. It should be remembered that the pruning of limbs or causing even the slightest bark wounds renders a tree much more susceptible to infection. It is a mistake to club and otherwise mutilate promising sprouts in order to obtain a few chestnuts. Yet this practice is commonly indulged in by many people who permit haste and enthusiasm to over-ride their better judgment.

Although reduced in status, chestnut still comprises a fair percentage of the forest undergrowth. On the Mont Alto State Forest, where formerly it constituted 40 per cent of the timber, it now averages 9 per cent of all reproduction (See Table 3, Page 20). However, it makes up 22 per cent of the seedlings and sprouts over three feet in height, and 14 per cent of those attaining six feet or more. From the standpoint of the three tallest saplings recorded on each of 60 study plots, chestnut stood second to red maple, with an average height of 5.9 feet for all sites.

When considered from the standpoint of chestnut replacement, it cannot be denied that this prolific development of rapidly-growing chestnut sprouts presents a hindrance to the establishment and growth of other species. On many cut-over areas there is produced a dense thicket of sprouts, often so numerous as to shade out much desirable natural regeneration. Presence of sprout clumps, particularly when they monopolize considerable growing space, postpones indefinitely the normal development of fully-stocked stands. Neither can artificial replacement be justified when the planted trees have so little chance to survive, and to resort to liberation cuttings only serves to stimulate an increased production of sprouts. Perhaps when the chestnut has developed more complete resistance to the blight or else has entirely succumbed to it, these areas will revert again to normal conditions.

Introduction of Foreign Species of Chestnut

During recent years the United States Department of Agriculture, Bureau of Plant Industry, has made a determined effort to discover a blight-resistant strain of chestnut that will be suitable for reforestation (9, 10, 11). Many varieties of Asiatic chestnut, principally from China and Japan, have been introduced into this country. The policy has been to establish experimental plantings of these exotic species in many eastern states for the purpose of determining their adaptation to our soils and climate, susceptibility to blight attack, and relative value as a forest tree. Thus far the Japanese chestnut (*Castanea japonica*) and the hairy Chinese chestnut (*Castanea mollissima*) have given most promise. Several plantations of these species have been established by the Pennsylvania Forest Research Institute in the Mont Alto State Forest. Although none of the imported trees has proved to be entirely immune to the blight, some of them show considerable natural resistance. The principal objection to their use for forest planting is that they apparently are suited more for orchard culture than for the production of timber. However, there is the possibility that by crossing them with our American chestnut there may in time be developed a tree that will be adapted to forestry purposes.

SUMMARY

1. The chestnut blight (*Endothia parasitica*), first noticed in southeastern Pennsylvania in 1909, had infected most of the extensive stands of chestnut in the State by 1915, and by 1920 had killed practically all trees except in the extreme northwestern counties.

2. Chestnut was one of the most common and most valuable timber trees of Pennsylvania. Its abundance and rapid growth on relatively poor sites, and the value of its wood for many products, made it one of the best species for profitable

forest management. Its loss was a great calamity, seriously complicating the forestry program with difficult economic, silvicultural and biological problems.

3. The major purpose of this study is to determine what Nature is doing to replace chestnut with other species, how satisfactory natural replacement promises to be, and what can be done artificially to promote or improve the natural replacement process.

4. The study was begun in the summer of 1930 in the Mont Alto State Forest in Franklin County, the field laboratory of the Pennsylvania Forest Research Institute, because this region is typical of the extensive oak-chestnut-hard pine forest type of central, southern and eastern Pennsylvania. Later the study was extended to all parts of the State where chestnut was formerly abundant, so that any differences of conditions in the various regions might be noted. Altogether, nearly 3,000 plots in chestnut openings were studied and the following facts were determined.

5. The growth of most trees in openings formerly dominated by chestnut was very noticeably stimulated, due to increased light made available, more room for crown expansion, and lessening of root competition. A wide difference of growth acceleration was found to exist between species, and even for individuals of the same species, depending on such factors as site, percentage of chestnut in the stand, age, crown class, and ability to withstand shade. Increment borings, taken from 603 trees representing ten different species, showed that in general diameter growth had increased 80 per cent during the decade following death of the chestnut. In most instances the greatest increase occurred within five years after the chestnut was dead.

6. With loss of the chestnut the growing stock of vast areas of our forests became seriously depleted. Records from permanent growth study plots show that most stands which formerly supported less than 40 per cent of chestnut by volume are now making fair progress toward recovery of their original status. Where chestnut made up 40 to 60 per cent of the stumpage the present wood volume still shows a deficiency of 5 to 35 per cent, based on stands of middle-age and older. Only where chestnut was less than 10 per cent of the original stand is the total volume greater today than what it was before the invasion of the blight, although it is fair to assume that if the chestnut had not died the rapid growth of this species would have resulted in a much greater volume increment.

7. On all excepting the poorest sites and where chestnut formerly made up more than half the stand, there is now generally sufficient advance growth and reproduction to compose a new stand of satisfactory density, but often of poor quality.

8. Under natural forest conditions, the species replacing chestnut comprise those that formerly were most closely associated with it. From 35 to 50 per cent of the replacement growth in Pennsylvania consists of oak, with rock oak in the leading role. In practically every locality red maple and rock oak are the two leading replacement species. Their numbers far exceed any of the others. Together they represent over 40 per cent of all advance growth and 30 per cent of all reproduction now present in the forest openings left by chestnut.

9. Approximately 50 per cent of the young growth, now competing for possession of the space vacated by chestnut, consists of less desirable species. The most numerous of these weed species, in their order of abundance, are red maple, sassafras, black gum, Juneberry, black birch, flowering dogwood and scrub oak. Not infrequently, too, it is the presence of woody shrubs and herbaceous plants that has hindered establishment of the more valuable timber trees.

10. A study of height growth of reproduction showed that ordinarily the tallest seedlings and sprouts that have appeared in the chestnut openings are not of preferred kinds. At different successive height levels there was a steady decrease of the more desirable trees, with a corresponding increase in the proportion of less

desirables. Also, a considerable part of the advance growth which now dominates the chestnut openings consists of trees that formerly were suppressed and poorly-formed, again being gradually overtopped by surrounding crowns, and hence capable only of poor growth though sufficient to suppress reproduction of better species underneath.

11. It should not be assumed that this abundance of inferior trees and shrubs on blight-killed chestnut areas can be attributed entirely to conditions resulting from loss of the chestnut. Repeated clear-cutting, fires, and a constant culling of the better species are the agencies most responsible for forest deterioration. The chestnut blight only served to aggravate further what already was apparent for decades previously, namely, the gradual ascendancy of undesirable shrub-weed species in our second growth forests.

12. Intensive fire protection, forest improvement thinning with release cutting of reproduction, and supplemental planting where necessary are the measures advocated to restore our chestnut-depleted forests to full productivity and to restock them with the best of our native species. Nature's efforts toward the replacement of chestnut must be supplemented by silvicultural improvement practices, in order to bring about a successful reestablishment of the more valuable timber trees that once were so common in Pennsylvania.

13. As another phase of chestnut replacement, it is apparent that, despite the efforts of its companion species to crowd into and close the forest openings that it was forced to vacate, chestnut too is struggling to maintain itself in the forest structure of Pennsylvania. Recent evidence of progress gives rise to additional hope that the tree is now entering a new era in its long fight to evade extermination. How much of this progress is due to the reduced production of spores because of the complete disappearance of host trees of any size remains to be determined.

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Forest Taxation in Pennsylvania



(Bulletin 55)

COMMONWEALTH OF PENNSYLVANIA

George H. Earle, Governor

DEPARTMENT OF FORESTS AND WATERS

J. F. Bogardus, Secretary

Harrisburg
1936

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FOREST TAXATION IN PENNSYLVANIA

by

E. A. Ziegler

Principal Research Forester

Introduction: Effect of Repeated Annual Taxes on One Long Time Crop and Related Problems

One of the basic elements involved in deciding the financial feasibility of private land owners growing forest crops, is the amount of the annual tax payments which have to be paid on land and trees many years in succession before the timber crop is marketable. Though somewhat variable for different species of trees, a rough approximation of the average number of years required to grow trees of a given size in wild untended forests in Pennsylvania is to allow 6 years for each inch of tree diameter (measured at 4.5 ft. from the ground). For rapid growing trees in properly thinned plantations this period may be reduced to 4 years per inch of diameter. Thus for pulpwood, mine props, and posts, trees must grow from 25 to 35 years, and the property owner, under the general property tax, must pay that many annual taxes, as well as other costs, from the tree crop income. For electric poles and railroad ties taxes must be paid for 48 to 60 years and for trees fit for lumber 50 to 75 and more years. When young trees have already attained a certain diameter, the remaining period of waiting is proportionally reduced.

Individual rapid growing trees in the stand may be harvested in perhaps one fifth less time, and the slower trees in a stand in one fifth more time. These are generalizations and specific information* on given species and locations will shortly be available.

When it is recalled that a 10 per cent acre annual tax with 5 per cent interest compounded amounts to \$1.26 per acre in 10 years; \$6.64 per acre in 30 years; and \$35.36 per acre in 60 years it is easily seen the average annual tax levies on an acre of forest land must not be much above 10 cents per acre per year.

When this tax accumulation is widely understood more Pennsylvania forest owners now paying at two, three, or more times the above sum, will ask to have their lands listed as "Auxiliary State Forest," with their annual tax reduced to that levied on a \$1.00 per acre assessment and then pay 10 per cent of the final stumpage value as a severance or "yield" tax. This system has been placed in our state law in 1913 (declared unconstitutional in 1934 and re-enacted in 1935 to meet court objections) to relieve forest land owners of the excessive tax accumulations on their long time crop of timber, but to date only about 50,000 acres have been classified.

Besides this need of quantitative data on forest taxes paid by the private forest owner, the state must use this data to weigh the fairness of its present annual payment of 5 cents per acre in lieu of taxes on its exten-

*Studies by the Division of Research, Pennsylvania Department of Forests and Waters are well along to furnish exact data on the rate of growth and timber yields of (a) forest plantations of various species over the state; (b) for the oak type natural stands in the central and southern parts of the state; and (c) for the empirical stand and growth actually on the depleted state lands.

sive state forest holdings and 4 cents paid on Auxiliary Forest lands. If these sums, fixed 25 and 20 years ago, are found unfair now, what are fair payments?

Also, what part of the total real estate tax comes from forest land in the various counties, and what is the effect on local tax income of extending the state or federal forest lands?

What forest tax burden results from the present state policy barring merchantable forest from the "Auxiliary State Forest" classification?

What is the situation of Pennsylvania forest land as to tax delinquency, and reversion to the government for non-payment of taxes? In some out-of-state forest states this is a most serious question.

For these and other questions authentic data on forest taxes are necessary.

COOPERATION IN THIS STUDY

The Pennsylvania Mineral and Forest Land Taxation Commission was established by the General Assembly with the Approval of the Governor in 1931 "to study, investigate and report upon the taxation of forest and mineral lands, and the distribution and application of such tax; * * *." The Director of the Forest Research Institute* was elected Secretary to this Commission, and cooperation between the Department of Forests and Waters and this Commission in the study of forest taxation was agreed upon. The Department furnished the personnel and the Commission met the field and most of the clerical expense of this study. Dr. F. P. Weaver, Head of the Agricultural Economics Department, Pennsylvania State College, and a member of the above Commission consulted in the outline and field work of the study.

OUTLINE OF METHODS OF TAXATION IN PENNSYLVANIA

The state raises its revenue largely from inheritance, corporation stock, corporate and municipal loan, insurance premium, public utility gross receipts, mercantile, gasoline sale, motor vehicle registration, and other non-property taxes. It does not tax property, real or personal, except the one mill¹ personal property tax levied for relief purposes in 1936 and 1937. This affects certain securities and money at interest only. The property tax field is left to the counties, local units (townships, boroughs, or cities) and school districts. The owner of real estate is subject to at least three² local taxes, county, school, township (borough or city) and where the poor tax is not merged with the county or township levy, a poor tax.

In addition to the real estate tax, the county taxes certain personal property as securities and money at interest uniformly at 4 mills,³ it also taxes occupations. Schools may add a per capita tax on voters, not to exceed \$5.00 but does not tax occupations; and the county, and local units

*Note the Division of Forest Research.

¹ Increased to 4 mills in 1936.

² Special item as bond taxes, city improvement assessments, etc., are subdivisions of these.

³ In 1929 money at interest and securities of corporations outside of Pennsylvania showed an assessed value 31 per cent as large as the real property assessment for all counties outside of Philadelphia and Allegheny (Pittsburgh).

(township, borough or city) add an "occupation" tax¹ (generally nominal). Cities may levy a municipal per capita tax instead of an "occupation" tax. Farm animals and machinery, furniture and other items of personal property (except securities and money at interest) are not taxed by any unit.

There is no state or local income tax except as the "occupation" tax is raised to a level where it might almost be classed as such. Indiana County for example assesses occupations as high as \$1500, to which the property tax rate is then applied. Such high assessment is very exceptional.

Every three years a "triennial assessment" is made of all real property. This is supposed to hold for the three years. It is supposed to adjust assessments to changed values and add new buildings or remove destroyed buildings and record changed owners annually. As a matter of fact coal assessments are adjusted annually for depleted land, and oil-well valuations are adjusted annually on their preceding years output (McKean Co.). Minerals severed in title are generally separately assessed as real property to the owners of the title. Gas wells and leases and in some counties* oil wells and leases have escaped taxation, except the light state capital stock tax when owned by corporations.

Standing timber is part of the land value and in Pennsylvania is assessed to the owner of the land, even though the timber right or lease has been sold to another.

The property assessing is done by a local elected assessor, except in counties of the first, second and third classes (7 most populous counties) where the county is the assessing unit. The record book of assessments for each township, borough or city unit is called an "assessment duplicate" and is filed in the office of the County Commissioner. Cities may make an independent assessment from that holding for the county tax, but counties, townships, boroughs, and school districts use the same assessment data to which are applied the separate tax rates.

County Commissioners sit as a board of assessment appeal and are supposed to equalize assessments. This seldom works out and uneven township and town ratios of assessed value to true value enable those units with the lowest assessment ratios to foist part of their county tax on those with higher ratios. Boroughs and cities studied generally appear to have lower assessment values in relation to sale value, and this increases the county tax burden on rural property (see data on assessment ratios submitted). A county assessor or board of assessors, trained in property valuation would be able to reduce these inequalities between local units, as well as reduce individual inequalities within units. This is now in effect in 3rd class counties, none of which are strongly forest counties and do not appear in this survey.

Another reason for low assessment ratios is to keep the *total assessed valuations* low and thus limit county or municipal bond issues which are permitted by the state constitution to a limit of 10 per cent of the *total assessed valuation* (7 per cent by majority vote, 3 per cent additional by a three fifths affirmative vote).

¹ In 1929 the "occupation" assessment was 7% as large as the real property assessment.

*McKean and several other counties have property taxes on oil wells.

The state pays 5 cents per acre (2 school, 2 road and 1 county) on state forest lands in lieu of taxes. On "Auxiliary Forest" lands, which are private forest lands classified under the "Yield Tax" law, the state pays the local government 4 cents per acre (2 to schools, 2 to roads) annually while the owner pays on a \$1.00 assessment only.

On national forest lands in the state, the state pays 5 cents per acre also, until such a time as the 25% of the forest income paid by the National Government to the local governments, in lieu of taxes, shall equal or exceed the amount paid by the state, at which time the state payment will cease.

DEFINITIONS

"Assessment value" or "assessment" is the value placed on property by assessors to which is applied the "tax rate" (stated in mills per dollar assessed value). The assessment value is supposed to represent full (market) value, but assessments on individual properties have been supported by the courts when they represent less than full value, if they are in harmony with the general county assessment ratio. As a matter of fact, in the 8 counties studied the *average assessment* for taxes has in no case equalled the average sale price (voluntary sales), for any class of property examined such as "residence and business" property, "farm" property or "forest" property, nor for any period even including 1930-32. *Individual properties* have been found assessed at over 100 per cent of sale value however.

"Assessment ratio" is assessed value divided by sale value in unforced sales.

"Seated" land on the assessment duplicates originally meant land with improvements, generally some cleared, and often enclosed and containing a house or other buildings. "Unseated land" is generally wild or unimproved (if mineral, undeveloped) land and is almost invariably forest land (surface), with a little scattered abandoned farm land as the exception. Not all counties use the classification "unseated land." In some counties the local tax collector collects only on "seated" property, the county treasurer handling the tax collection on "unseated" lands.

"Tax delinquency" is measured herein in its final state (except where otherwise noted)—by the amount of property sold for taxes and not redeemed within the statutory two years by the former owner. In Franklin County tax sales have not been used to liquidate delinquency, since up to 1932 it was not serious. Here "tax liens" were filed in the prothonotary's office against delinquent property, and kept alive by proper renewals. The liens must finally be paid before a buyer can get a clear title. In Franklin County tax liens were listed as the measure of final delinquency.

Tax delinquency has been greatly exaggerated by reporting percentages of current levies unpaid at the end of the tax year. There is always a human element that is tardy in all things and tax paying is no exception. The only fair way of measuring real delinquency in collection is to compare *all tax collections*, due and over-due, against current levies, though the final measure is the tax lien or unredeemed tax sale volume.

SELECTION OF COUNTIES*

Since the property tax is limited to county, township (or municipal) and school purposes in Pennsylvania, and since the assessment rates are supposed to be somewhat uniform within each county, because the county commissioners sit as a board of assessment appeal, the county was selected as the unit in this study. The county is also the largest of the local tax units. The county treasurer also handles the unseated land tax collection for the entire county, as well as tax sales in many counties.

The most serious aspects of forest taxation were expected to be found in the sparsely settled cut-over forest counties, lying in the Appalachian mountain belt. These include such counties as Sullivan, Center, Potter, Clinton and Elk, with 66 to 86 per cent of their area in forest. They are counties containing large areas of State Forest. To these were added Adams, Crawford and Franklin, where the forest is 22 to 30 per cent of the county area and where agricultural property forms a larger part of the tax base.

These selected counties (see Fig. 1) could not be distributed over the state with entire satisfaction from the statistical "sampling" standpoint for two reasons. First, it was necessary to avoid the anthracite and bituminous coal fields, and the oil and gas areas, since mineral values often are accompanied by nominal and distorted surface values when they are separated, and in many cases they are not separated. Pike, Wayne and Monroe counties with their recreational values were also avoided. Second, the county tax records must segregate forest lands from cleared farm lands sufficiently for securing reliable average values. Preliminary examination caused the rejection of four counties due to a failure to sufficiently segregate and identify forest lands on the tax records. In these counties cleared and forest lands were assessed together in lump sums, often including buildings.

The eight counties surveyed contain 2,518,000 acres of forest land or almost 20% of the total forest land in the state. They contain 37 per cent of the total state forest and game land areas. The survey is of sufficient extent therefore to reflect forest taxation conditions in those parts of the state where state lands largely lie, and where forest tax income is an important item in many local government budgets. It is in these portions of the state that most of our future forest products must be grown.

*More detailed township tables are given in the eight mimeographed "County Reports."

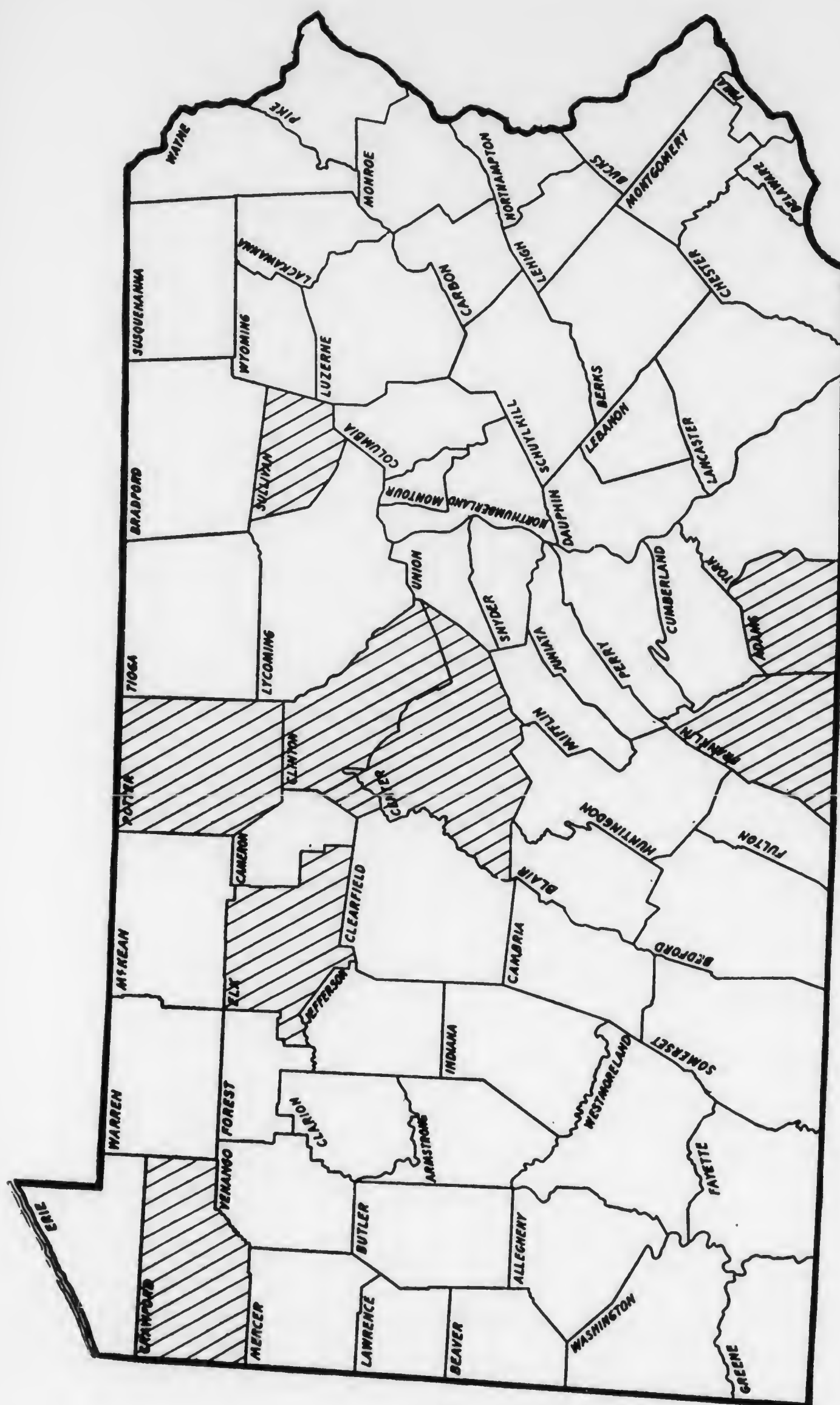


FIG. 1. LOCATION OF THE EIGHT COUNTIES STUDIED FOR FOREST TAXATION

METHODS OF THE SURVEY

On entering the county the first step was to summarize the acreage and assessed value of all forest land separately assessed. This was secured from the township assessment books in the County Commissioners office for "seated lands," and the "unseated land" assessment and tax book in the Treasurer's office where this property distinction was made and handled by the treasurer. Total property assessment value, number of taxables (persons over 21 years), total "occupation" assessment value, money and securities taxable for county purposes, and county (and poor), township (borough or city), and school property mill rates were ascertained; also per capita school and per capita city tax (substituted for "occupation" tax) were secured. Areas of State and National Forest lands were secured from the officers in charge.

From these data (checked by "woodland in farms" data from the 1930 Census of Agriculture) the forest area privately and publicly owned was determined; also the total property assessment value and private forest assessment value; total property tax and forest tax (including government payments in lieu of taxes); assessment per acre of forest and average, maximum, and minimum forest tax per acre. These values were secured by county sub-divisions, viz., townships, boroughs and cities.

Recorded deeds in the recorder's office were examined for properties sold and having the full purchase price recorded. These were taken in the order in which they came. Assessed values for the same properties were tabulated from the assessment duplicates for the year of sale. From these sample values "ratios of assessment to sale value" were computed for "residence and business (generally town) property," "farm property" and where sufficient records could be segregated "forest property." In several counties sufficient data for "pre-depression" and "depression" (1930-32) assessment ratios were secured. Forest property was the most difficult to handle since lumbermen often bought timber only—which was not recorded in the county records. Frequently when the land was also bought it was again quickly sold and identification or segregation was not possible on the assessor's books.

Only by multiplying tax rates on assessed value, by the ratio of assessed to market values, can tax rates on market values be secured for comparison with rates on market values elsewhere. *Tax rates on assessed values in different tax units are not comparable*, because of this difference in assessment ratio.

The tables and figures in this general report are generally consolidations of more detailed figures given by county subdivisions in the mimeographed county progress reports for the eight counties studied.

TOTAL FOREST AND LAND AREA

A critical examination of many of our mountain counties, township by township,* emphasizes the predominant place of the forest in our land use economy. Even for the entire state (Fig. 2) the present forest with an area of 13 million acres exceeds the cleared farm land by over a million acres. This large forest area is being augmented by over 2 million acres of cleared farm land abandoned since 1910, which must return to forest. It is this *preponderant forest area* that must to a degree measure the im-



FIG. 2. LOCATION OF FOREST LAND IN PENNSYLVANIA
Compiled by the Department of Forests and Waters

portance of our forest in our economic life over a long period of time. The flood of forest products that once flowed from it, and that can again flow from it, and not the present depleted trickle only, must be taken into consideration in measuring the justifiable forest investment by the public as well as by the private owners. The restoration of the huge forest capital and income producing value on over one half of our state land area, for which there is no other profitable use, must be assisted and stepped up by government forest research even more than state agricultural production was stepped up by government agricultural research. *Agricultural crops have caught up with and even exceeded the demand. Forest crops are far behind our normal consumption.* Erosion control and the reduction and retardation of run-off flood waters are most important functions of forest cover in this state.

Table 1 reflects the preponderant place of the forest in the land economy of the several forest counties examined. A separate survey** reveals that 2 to 10 per cent of the land area of these counties is now in cleared land dropped from the farm classification since 1910. This land will ultimately be added to the present forest area by inferior natural reforestation if not properly reforested by planting.

*See detailed county tables in the mimeographed county "progress report."

**See Bul. 51, "Reforesting Pennsylvania Idle Land as a Self-liquidating Public Work," Penna. Dept. Forests and Waters.

TABLE 1 Summary of Forest Land in Eight Counties Surveyed (1936)

County	Total Land ³ Area	Forest Area		Forest Ownership			
		Total (Acres)	Part of Total Land (Per Cent)	Government ⁴ (Acres)	Private		
					In Farms ³ (Acres)	Outside Farms (Acres)	Total Private (Acres)
AGRICULTURAL COUNTIES							
Adams	337,920	83,309	25	20,992	44,436	17,881	62,317
Crawford	664,463	172,308	26	3,522	114,243	54,543	168,786
Franklin	480,640	143,077	30	40,771	49,388	52,918	102,306
FOREST COUNTIES							
Sullivan	293,120	193,440	66	78,792	26,441	88,207	114,648
Center	733,598	518,649	69	143,415	66,016	309,218	375,234
Potter	685,588	502,783	73	262,720	94,875	145,188	240,063
Clinton	562,041	460,008	82	245,985	33,392	180,631	214,023
Elk	515,951	443,499	86	¹ 212,140	23,706	207,653	231,359
Total Surveyed.....	4,273,321	2,517,073	....	² 1,008,337	452,497	1,056,239	1,508,736
Entire State	28,692,480	13,083,679	46	2,541,989	3,665,540	6,876,150	10,541,690
Per Cent of Total Forest.....	.....	100	....	19	28	53	81

¹ Includes 105,421 acres National forest land in 1936.

² By extensive purchase from 1931 to 1935 Government forest land in these counties has increased to 1,008,337 acres as of Jan. 1, 1936, from 793,268 acres as of 1931.

³ Farm and total land is taken from 1935 Census.

⁴ State Forest and State Game and National Forest land.

THE PRESENT IMPORTANCE OF FOREST PROPERTY IN THE REAL PROPERTY TAX FOR COUNTY¹ AND LOCAL TAXES

Table 2 sets forth the total amount of the forest assessment in 3 agricultural counties and 5 predominantly forest (based on area of forest land) counties. The total real property assessment for the entire county (including municipalities), the real property assessment for the townships alone where the forests lie and the relation of the forest assessment to these totals are included. Since real property pays about 80 per cent² of the county and local taxes, the relation of the forest assessment to all real property is a good measure of its importance in the tax base of the different counties.

In Potter and Sullivan counties only of the eight, the forest forms over 6% of the county real property tax base (Table 3, Col. 4). Therefore except for the few very sparsely settled counties as Potter and Sullivan the forest tax is of no great weight in the county budget.

¹ There is no state tax on real estate in Pennsylvania.

² The other 20 per cent is paid on securities and money at interest, occupation, and per-capita school and city taxes.

TABLE 2 Relation of Forest Assessment to Real Property Assessment for County, all Townships, High and Low Townships

County	Part of Total Land in Forest	9 Real Property Assessment							
		Total for County	Forest to Total	Forest to Total	Townships Total	Forests to Townships Total			
						All Twps.	Max. Twp. Min. Twp.		
(1) (per cent)									
(2) (thousand dollars)									
(3) (thousand dollars)									
(4) (per cent)									
(5) (thousand dollars)									
(6) (per cent)									
(per cent)									
AGRICULTURAL COUNTIES									
Adams	25	17,157	1	526	3.1	11,419	4.6	12	2
Crawford	26	35,744		2,072	5.8	16,927	12.2	40	2
Franklin	30	36,033	3	503	1.4	20,186	2.5	11	1
FOREST COUNTIES									
Sullivan	66	2,970	4	361	12.1	1,989	18.1	64	5
Center	69	15,825	5	705	4.5	9,681	8.2	63	1
Clinton	82	12,121	6	596	4.9	4,511	13.0	69	1
Potter	73	5,147	7	994	19.3	3,189	30.8	67	12
Elk	86	9,425	8	558	5.9	3,261	17.1	41	11

¹ Based on 80 per cent of privately owned forest separately assessed.

² Based on 11 per cent of privately owned forest separately assessed.

³ Based on 93 per cent of privately owned forest separately assessed.

⁴ Based on "unseated" forest assessment which includes 62 per cent of the forest land. There appeared to be little difference in "seated" and "unseated" forest land assessment values.

⁵ Based on 100 per cent of private forest which was separately assessed.

⁶ Based on 100 per cent of "unseated" forest and 55 per cent of "seated" forest separately assessed.

⁷ Based on 100 per cent of private forest which was separately assessed.

⁸ On account of mineral values, the forest assessment is based on separately assessed surface only, embracing 23 per cent of the forest land.

⁹ In addition to the real property assessment, see Notes ³ Page 4 and ¹ Page 5 under "Methods of Taxation in Pennsylvania," for county tax on money and securities and township and municipal assessment of "Occupation."

But for township and school taxes the forest tax is much more important. It forms from 12.2 to 30.8 per cent (table 2, Col. 6) of the real property tax base for all townships in 5 of the 8 counties. And for single maximum townships the forest forms as much as 69 percent of the real property tax base. Anything that reduces the forest tax income is therefore very important to these highly forested townships and their school districts. The acquisition by the state or national governments of forest lands, and the listing of private forest land as "Auxiliary State Forest" whereby the local annual tax income is fixed at 5 cents on government bought land, and 7 to 9 cents¹ per acre on private "Auxiliary Forest" land, generally does reduce the local forest tax income. When such purchases or listing include a large percentage of the forest in any one township the local tax income may be seriously affected.

In such counties as Franklin, Adams and Center the forest forms such a small part of the tax base even in the townships, that the extent of acquisition of forest land by public agencies is of no great moment except in a few maximum forested townships. Some of these maximum forested townships have such a low annual tax on private forest, as the 5.7 cents average forest-land tax in Burnside Township, Center County (forest forms 63% of total assessed value), that the amount of land taken over by the state (Paying 5 cents per acre tax) is of little effect on the township finances.

THE TAX BILL PER ACRE OF FOREST LAND

But in townships like Worth in Center County, where the forest forms 33% of the total real property assessed, and the forest averages 14.5 cents tax, the State taking over a considerable forest acreage and reducing the tax income to 5 cents, would embarrass the township budget.

Also in a country like Potter, where the forest forms 19.3% of the real estate assessment and the average total forest tax for the county is 15.6 cents per acre, large state purchases with consequent reduction of tax payments to 5 cents per acre are bound to be felt. In Summit Township, Potter County, the forest assessment forms 51% of the total real property for the township. The average private forest tax is 19.9 cents per acre, which would be reduced to 5 cents on state land with great loss to the local tax income. Other counties and townships could be quoted to emphasize this serious reduction of local tax income on extensive acquisition of state or national forest land.

From these facts it may be strongly argued that the state should raise its tax substitute payment from 5 cents to perhaps 8 cents on State Forest lands.

¹ 4 cents paid by the state and 30 to 50 mills on \$1.00 valuation by the owner.

TABLE 3 Assessed Values Per Acre of Forest Land

County	Assessment Per Acre of Forest Land				
	Merchantable Forest Maximum	Lowest Township Average	Highest Township Average	Average for all Forest	Average for "Unseated" Land Only
FARM COUNTIES	1 (dollars)	2 (dollars)	3 (dollars)	4 (dollars)	5 (dollars)
Adams	125.00	4.99	45.70	10.04	.....
Crawford	66.67	8.66	18.71	12.40	.....
Franklin	167.00	1.45	30.94	4.69	.....
FOREST COUNTIES					
Sullivan	100.00	1.44	7.36	2.75	2.75
Center	33.33	1.03	4.26	1.77	1.46
Potter	20.00	1.49	6.22	2.76	2.35
Clinton	150.00	1.98	6.21	2.58	2.45
Elk	10.32	.97	3.62	1.98	1.70

TABLE 4 Annual Taxes Per Acre on Forest Land in Eight Counties

County	Annual Tax on Forest Land				
	Maximum (Merchantable Forest)	Lowest Township Average	Highest Township Average	Average for all Forest	Average for "Unseated" Land only
	(1) (dollars)	(2) (dollars)	(3) (dollars)	(4) (dollars)	(5) (dollars)
Adams	4.25	.18	1.33	.325	.....
Crawford	3.27	.09	.78	.510	.....
Franklin	5.51	.05	.81	.136	.....
Sullivan	4.50	.07	.30	.124	.124
Center	1.22	.05	.15	.081	.078
Potter	1.18	.06	.30	.156	.13
Clinton	7.40	.04	.20	.086	.086
Elk	.54	.07	.23	.125	.125

Table 4 last column indicates that such an increase of state payment to 8 cents per acre would still fall short of the average private owner tax payments even on unseated lands in all counties studied except Center.

Several facts should be recognized justifying a state payment below the average private payment:

(1) The state lands include much land that would have gone tax delinquent under private ownership. A low state payment is better than no tax.

(2) State purchases have encouraged private owners to hold and pay taxes with the hope of selling to the state.

(3) There are other state tax equalizing appropriations to schools and roads of rural units.

(4) Recreation and hunting camps on leased state lands may be taxed to their owners which adds tax income to the state payments.

Based on these facts the 1933 State Mineral and Forest Land Tax Commission Report recommended an 8 cent payment on state owned forest lands, auxiliary forest tax lands and temporarily on federal forest lands

within the state. The division recommended was 4 cents for schools, 2 cents for roads and 2 cents for county purposes. This increase of 3 cents per acre would require an increased state payment of about \$75,000.

As the state is moving toward maintaining all rural roads, thus lifting the road tax from real property including forest lands, the Commission recommended a 6 cent per acre state payment when the township road tax is entirely withdrawn, 4 cents to schools and 2 cents for county purposes. This would add \$25,000 to the state payment on government owned land.

When the State Forests have generally increased the size and quantity of their standing timber so that a considerable net income appears, a reconsideration of forest values and the payment in lieu of taxes should be made, based on forest income.

MAXIMUM FOREST TAXES ON MERCHANTABLE FOREST

In column (1) Table 4, are given maximum annual taxes on merchantable timber. Much of this merchantable timber is in small tracts on farms. There is a tendency in some townships to assess farms at a flat rate per acre—crop land and forest land alike, apparently on the assumption that the farm total assessment is the only fact that need be considered. But many cases can be found where the timber assessment is based on its market value. When timber reaches saw-log size its volume growth falls to 1 or 2 per cent, based on the large volume standing, and even when allowance is made for rising values over a period of years, the earning power of this timber is seldom over 3 per cent. This applies generally to high value timber in settled states like Pennsylvania. Tax rates of 1.9 to 5.1 per cent (19 to 51 mills) on full sale value generally confiscate not only all increment but even in time much of the principal of such timber investment.

The objection may be made that such timber is financially mature and should be cut. While it is true that the owner would be financially better off if he cut the timber and invested in government bonds (3% yield and tax free), the presence of woodlots on farms, and the holding of our remaining merchantable timber for gradual liquidation while the large cut-over areas are growing up, have general social and industrial values that merit consideration. Certainly the least that can be done for these timber owners is to permit them to classify these merchantable timber "remnants" under the Auxiliary Forest Tax Act with an annual tax based on the nominal assessment of one dollar per acre and the additional payment of a yield tax. Instead of a flat 10 per cent yield tax however, in consideration of the long series of annual taxes already paid, the yield tax should be fixed at one half of one per cent for each year classified until the tax reached the maximum of 10 per cent after 20 years of classification. The time of cutting should be decided by the owner and not by state officials.

These recommendations have been indorsed by the State Mineral and Forest Land Tax Commission in their 1933 report. Such changes in the Auxiliary Forest Tax Act would not work hardship on local government units, since the aggregate extent and value of merchantable timber in the state is a small fraction of the property value in any county. For example, less than 2% of the privately owned forest land in Sullivan County* is listed as hardwood or hemlock "timber" and its assessed value is about

3% of the total assessed value of all real property in the townships or 2 per cent for the total county assessed value including the boroughs. Sullivan County has the next to the highest total forest property assessment percentage to all township property assessment (18.1%, Table 3) of the 8 counties studied, so that its merchantable timber assessment percentage may be regarded as far above the average percentage of the township property assessment generally. It may be remarked that these high taxes on merchantable timber are apparently rapidly leading to its cutting where the owner has his timber property segregated and can see clearly what holding it is costing him. In Sullivan County (66% forest) there are but 102 acres of the original hemlock timber remaining; 100 acres of this is in one tract and this is assessed at \$100 per acre. With a 40 mill tax rate the taxes are \$4.00 per acre a year. The owner is reported to be planning to cut it unless a local movement for government acquisition as a "park" or "monument" of the virgin forest goes through.

FOREST ASSESSMENT AND MARKET VALUE RATIOS AND TAX RATE ON SALE VALUE

Real property assessment is supposed to be based on market value. In practice tax assessment is purposely placed at less than 100 per cent of market value (1) to keep total assessment down and limit total bond issues which may not exceed a percentage of assessed value: (2) in an attempt of subdivisions (townships, boroughs, cities) to reduce *their* share of a uniform tax laid by the larger division (county); (3) to carry favor with the property owner by giving him the idea that his property is favored.

Unequal assessment of property classes is brought about by their segregation in government subdivisions. Thus the great bulk of residence and business property is located in boroughs and cities, while farm and forest property is in the rural townships. Local assessors generally are average local citizens with no special knowledge of property values. Assessments are copied from preceding "duplicates" period after period. General changes (upward) are made when tax rate manipulation no longer meets the tax income requirement, or in single properties (downward) when a strong fight is made by the owner. A small percentage of property apparently escapes taxation altogether—mainly by the understatement of acreage in the farm and forest classes, and the failure to return for assessment separately owned town lots. Possibly political favoritism has some bearing on the result.

*Sullivan County was the only county segregating "timber" land from cut-over lands on the tax rolls.

TABLE 5 Tax Rates on Assessed Value, Ratio Assessed to Sale Value, and Tax Rates on Sale Values of Property
(Average for the County)

County	Total County, School and Township or Town Tax Rate on Assessed Value			Ratio Assessed to Sale Value			Tax Rate on Sale Value		
	Res. and Business Property (1)	Farm Property (2)	Forest Property (3)	Res. and Business Property (4)	Farm Property (5)	Forest Property (6)	Res. and Business Property (7)	Farm Property (8)	Forest Property (9)
FARM COUNTIES									
Adams	(Mills) 34.8		(Mills) 33.6	(Per Cent) 45	(Per Cent) 71	(Per Cent) 65	(Mills) 16.5	(Mills) 23.0	(Mills) 19.5
Franklin	36.6	32.4	30.0						
FOREST COUNTIES									
Crawford	48.3	41.1	41.1	48	80		23.0	32.9	
Sullivan	43.0 (est)	45.0 (est)	45.0	55	61		26.2	27.4	
Center	54.7	39.9	45.9	29	54	59	15.9	21.5	26.6
Potter	70.6	55.9	56.7	31	43		21.9	24.0	
Clinton	47.0	36.0	33.0	41	49	57	19.2	17.6	18.8
Elk	75.2	66.0	63.1	32	45	82	24.0	29.7	51.7
GRAZING COUNTIES									
Greene	36.4	26.3		37	60		13.5	15.8	

^a Based on 91 properties (46 residence and business, 35 farm, 10 forest) sold in 1930-31. Ratios for 1926 to 1929 (144 properties) were 36, 64 and 22 per cent for residence and business, farm, and forest property respectively.

^b Based on 64 properties, 33 mixed farm with forest, and 32 residence and business properties for period 1924 to 1926.

^c Based on 118 properties, 63 residence and business, 44 farm and 11 forest sold from 1924-1932. A summary of 1930-32 sales of properties alone showed little consistent increase in ratios.

^d Residence and business property ratio based on 196 sales, 1925 to 1932. A division into pre-depression and depression years showed little difference. Farm property ratio is based on 93 sales. Pre-depression ratio is 52.5% and depression period (1930-32) is 55.1%.

^e Residence and business property based on 12 sales 1929-32; farm property based on 7 sales; forest property based on 11 sales.

^f Residence and business property based on 38 sales (1927-32); farm property based on 62 sales; forest property based on 17 sales.

^g Residence and business property based on 27 sales in 1930 and 31; farm property based on 33 sales. (Ratios for residence and business 1927-29 was 45% and farm 52%.)

^h Based on 33 residence and business properties and 47 farm properties sold from 1930-32.

The inequality of assessment is appalling as between individual properties. For example, in Table 5, Column 5, farm property in Center County has a *mean* or average assessment of 54 per cent* of the actual total sale value of the 93 farms sampled. But back of this mean or average value, the *individual properties* varied in percentage of assessment to sale value from 17% to 118%. In fact, the more uniformly assessed half** of the property value fell within 40 and 68 per cent of sale value. The other half was below 40 per cent or above 68 per cent. This large variation between assessment ratios for individual properties indicates the amount of improvement possible in the assessor's work.

Similarly, for the 196 residence and business properties sold in Center County from 1925 to 1932, the mean (and total) assessment was 29 per cent of the sale value. The probable error of this mean is ± 0.7 per cent and the standard deviation is 14.5 per cent, that is one half of the property value fell below 15.5 per cent or above 43.5 per cent of sale value on the assessment books. Individual properties were assessed at from 3 to 95 per cent of sale value. These are typical variations and show individual discriminations of large size.

An examination of Table 2 shows another glaring injustice in property assessment. Columns 4, 5 and 6 show that in every county the data indicate a higher rate of assessment for farm and forest property than for residence and business property (generally town property) in spite of the greater government supported improvements enjoyed in many of the towns, such as sewers, paved streets, etc. Even when the generally higher tax rates of the towns (Col. 1) are applied to the assessed ratio (Col. 4) the resultant tax rate on residence and business property based on full sale value (Col. 7) is less than that for farm and forest in each county except Clinton and Elk (farms only are lower in Elk). This lower assessment ratio on residence and business property puts an unjust share of the county taxes on the rural property. This property class discrimination is another argument for county wide assessment units, with trained assessors.

Columns 7, 8 and 9 indicating taxes of from 13.5 to 33.8 mills (on Elk Co. forest land 51.7 mills) on full sale value of real property, demonstrate further that in most agricultural and forest counties real property needs relief from the high tax burden. Farm and forest property generally do not earn more than 3 to 5 per cent (net before taxes) on sale value, and to pay from 1.3 to 5.2 per cent in taxes on full sale value is to require 40 to 100 per cent of the income for taxes. Quite clearly *a portion of the property tax burden should be shifted to non-property incomes*, and a more equal assessment laid on town property as compared to farm and forest property; also individual properties should be equalized.

*The "probable error" of the mean is $\pm 1.0\%$.

**The "standard deviation" is $\pm 14\%$.

TAX DELINQUENT FOREST LAND

Early in 1933 the Department of Forests and Waters made a canvass of 51 of the 67 counties of the state for a statement of tax-delinquent cleared and forest land. Estimates were made for the other 16 counties. The county records were very incomplete in classifying separately clear and forest lands. They also lacked uniformity in time of advertising tax delinquent lands for sale—the last sale advertised in some counties being for 1929 tax, others 1930 and others 1931 taxes. The figures given can be taken only as indicators of the seriousness of the property tax situation for farm and forest lands. Two classes of lands were tabulated (a) lands sold to the county for taxes, i.e., no private bidders at tax sale. (b) Lands advertised for sale for taxes but not yet sold. Lands sold and bought by private persons remain in the tax base—generally at much reduced valuations—and were not tabulated. The following statement gives the result of the canvass:

Land Class	Sold to County		Advertised for Sale	
	Area (Acres)	Assessed Value (Dollars)	Area (Acres)	Assessed Value (Dollars)
Cleared Land.....	139,996	2,033,028	264,161	7,643,709
Forest Land.....	412,101	1,953,144	326,476	1,296,533
Total.....	552,097	3,986,172	590,637	8,940,242

Over a half million acres is already in county ownership and many advertised sales are postponed for lack of bidders. Of this three fourths is forest land. More than another half million acres is advertised for sale of which only 55 per cent is forest. It is evident that a much larger portion of the cleared land sold at tax sales is redeemed or bought by private owners at the sale or within the statutory 2 years, than of the forest lands. When the tax sale reports for the 1932 and 1933 tax sales are available it is clear that these tax delinquent lands "sold to the counties" will show a large increase.

TAX DELINQUENT LANDS IN CENTER COUNTY

Center County may be cited as an example of the drift toward tax delinquency both of cut-over forest lands and the poorer farm lands. This county lies in the center of the state on the east slope of the Allegheny Mountains and is made up of a series of mountain ridges and narrow valleys. The southeastern half of the county has limestone valleys, settled early by Pennsylvania German farmers, who know how to maintain soil fertility. They are frugal, industrious and tenacious in farm ownership. They held their timber clearing for farms largely to the valleys and lower slopes, keeping the mountain ridges and upper slopes in forest. The northwestern part of the county was less carefully developed and contains more steep slopes cleared for agriculture and now abandoned. The record of sale for taxes for "seated" (generally farm) land, and "unseated" (forest land) shows as follows:

Year of Sale	Land sold biennially for taxes and not redeemed by the owner	
	"Seated" land	"Unseated" land
	(Acres)	(Acres)
1900-1912 average	291	22,618
1914-1928 "	424	21,788
1930-	1,438	42,663
1932 (sold)	1,030	.....
(advertised only sale postponed)	2,269	59,294

Twenty-eight thousand four hundred and sixty-nine acres of the unseated land has tax title taken by the county (July 1, 1932). If we add to this the land delinquent to the point of advertising we find 36% of the privately owned unseated forest land involved in delinquency and 7% already in the hands of the county before the 1932 sale which threatens a large increase.

It is quite possible that some of this delinquent area is a result of double assessment and poor county records. But it must also be noted that the state purchased 119,000 acres or 23% of the forest area of the county in past years,* which undoubtedly decreased forest tax delinquency materially.

STATE PURCHASE SHOULD BE INCREASED

Thus in spite of the large forest land purchase program of the state and federal government, forest and idle cleared land is reverting to the counties in increased quantities. This may be interpreted as evidence of the desirability of the state increasing its purchase of these lands—both sub-marginal clear land and cut-over forest land—for reforestation. The county owned land should first be purchased.

The recently enacted law (1933) permitting the counties to turn over to the state for reforestation lands acquired by the counties at tax sales and not redeemed within two years, and thus to get the 5 cent per acre state payment in lieu of taxes to the local government, expects too much civic spirit from the county officers. Repeated advertising, executing and recording deeds to the county, and later occasionally to private buyers at commissioners' sales, furnish fees that county officials will not lightly cast aside. This they would be required to do if they turned county tax lands over to the state for reforestation, without the state being authorized to pay advertising costs, title recording fees, and possibly a part of the back taxes, from funds appropriated for this purpose.

*To 1932. This percentage becomes 28% for Jan. 1, 1936.

CLASSIFICATION OF FOREST LAND UNDER THE AUXILIARY STATE FOREST OR YIELD TAX ACT

All this tale of forest land tax delinquency would lead one to think forest land owners would have their land classified as "Auxiliary State Forest" in order to secure the reduced assessment of \$1.00 before letting it go for taxes. Outside the state the law is being classed as a failure, when as a matter of fact it is generally unknown to forest land owners and is not being given a fair trial.* Since the administration of the act is assigned to the Department of Forests and Waters, the necessary publicity should come from this Department, as soon as its constitutionality is definitely shown.

As of Jan. 1, 1932, the private forest land classified as Auxiliary Forest Reserve includes 45,454 acres of which 28,440 acres lie in Cambria, Clearfield and Sullivan Counties. The first Auxiliary Forest Reserve Acts were declared unconstitutional in 1934, but were re-enacted in 1935 with slight changes. The 1934 decision invalidated the above listing under the Act of 1913. Under the Act of 1935 these owners are generally applying for re-listing.

CONCLUSIONS AND RECOMMENDATIONS

(1) Annual forest land taxes are too high in many of our counties, for the successful financial management under the sustained yield system by private owners. Taxes running over 12 cents per acre and year average for a 40 to 80 year or greater rotation can not be supported by any but the best stocked and protected forest. Particularly indefensible is the imposition of from 70 cents to \$5.50 per acre annual tax on the merchantable farm woodlands.

Although the present state maintenance of almost all township roads will reduce the tax burden on forest lands 25 to 30 per cent, relief from extortionate annual taxes should be granted;

- (a) by acquainting the public with the Auxiliary forest Reserve Act, and
- (b) by liberalizing this act to include merchantable timber with a sliding scale in the attached yield tax, one half per cent for each year of classification until the 10 per cent maximum is reached. The act should permit the owner to determine the time of merchantability. The act should be extended to farm woodlands of 5 acres or more in extent. Smaller areas could be easily brought up to this administrative minimum by planting.

(2) The state payment on State Forest and Auxiliary Forest lands to the local government units in lieu of taxes should include 4 cents per acre for schools, 2 cents for county and 2 cents for local roads until the road tax is abolished.

(3) The state forest purchase policy should be extended at once to include

- (a) All county owned tax lands, forested or cleared, that appear possible to weave into a satisfactory administrative unit at an early

*The constitutionality of this act is thought to be in doubt by some state officials, and its application is not being pressed until a new court decision is obtained.

date. Reasonable advertising and transfer fees should be paid on these lands and back taxes not to exceed 30 cents per acre.

- (b) All other forest lands on the market available at reasonable figures, which do not show promise of adequate private sustained yield management.
- (c) The purchase and reforestation of idle farm lands, where such are available in sufficient areas for satisfactory administration.

(4) For idle farm land areas and forest tracts too small for state administration, county and municipal forests should be encouraged by state assistance as is now being done in New York State.

(5) The county should be made the unit for property assessment. This would lead to trained assessors and equalize assessments as between business and residence, farm, and forest property and between individual properties of the same class.

Only a more vigorous state forest policy will reverse the present drift of large areas of privately owned cut-over forest and abandoned farm lands into a condition of economic and social threat to the state.

The water users of our cities need more pure water from forested areas.

The watersheds and reservoirs of our water power users, as well as flood periods (witness the March 1936 floods), need the regulating and silt preventing service of a better forest cover.

The people of the state want more and better recreation, hunting and fishing as working hours grow shorter, as the continued increase of hunting and fishing license income demonstrates.

Our wood using industries need a home supply of wood.

Our laborers need the employment.

And our home wood and timber markets will repay dollar for dollar the entire forest investment by the nation, state and communities, leaving the large social benefits of the forest free of final cost to the people.

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